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BRIEFLY TOLD.

CINCINNATI, O., May 15, 1889.—Dear JOURNAL: Beyond a doubt the Western Association's executive management—including the local committee, of course—are the most persuasive people in the West, for the opening day of the convention was ushered in by atmospheric conditions not far short of perfection. To put it epigrammatically, the scene in the Grand this morning was grand; that is, to a gas man—and gas men are easy to find just now "in and about" the corridors, etc., of about as comfortable a hotel as there is in the Queen City, if not in the West. The attendance must be very flattering to the gentlemen who have worked with such will to bring that result about; for no less than 100 were present to-day, and there is every likelihood that this will be greatly added to to morrow. Up to the hour of writing the Western's muster roll has had 25 new names inscribed on its pages, and there is no sign that the second day will not witness the admission of at least half as many more. Does this look as if the influence for good of our Associations is waning? The question leads me to remark that the one who would answer "Yes" thereto must be a rank type of dyspeptic pessimist. The visiting delegation, while not so numerous as had been counted on, is nevertheless very representative, North, East and South being present.

So far we have had acknowledgments from Commissioner Barker, Boston; Mr. Turner, Charleston, S. C.; Mr. Thos. Curley, Wilmington, Del.; Mr. W. H. Baxter, Petersburgh, Va.; Mr. C. W. Blodget, Brooklyn; Mr. W. Mooney, New York, and others.

Ramsdell makes a splendid presiding officer—in fact, one of the members suggested that it would be a good plan to make the term of the offices of President and Secretary without limit, provided Ramsdell and Littleton could be prevailed on to occupy the respective berths, without complaint. The President's address abounds in fruitful suggestions, the most prominent of which seemed to me to be, judging hastily from a memorized scanning of the message, the reference to the necessity for putting the gas business voluntarily under State control, and the peculiar appropriateness of interesting the fraternity at large in a scheme for a grand celebration by means of a "Centennial Gas Exposition," to be held some time in 1892—the epoch which will witness the centennary of Murdock's application of illuminating gas in a practical way for the lighting of his premises. Another valuable arrow in the bunch gathered by the President is found in his outspoken reference to the way in which the proprietors of gas companies ought to encourage the growth and influence of gas associations. This argument and its cause are no strangers to those who read the JOURNAL, and it was with peculiar interest and satisfaction that I listened to the President's plain way of putting the case. Another thing that I might note was his manner of handling the electric lighting question, which he treated right cleverly, in that he neither suffered himself to be torn by Scylla nor injured by Charybdis. Right down at the bottom, however, I imagine that President Ramsdell does not figure in the ranks of those who would blindly adhere through thick and thin to the vaunted value of the operation by gas companies of electric lighting plants. To come back to his Murdock centennial suggestion, we might remark that in connection therewith Mr. Ramsdell hints that in 1892 we will all be enjoying, nay, revelling, in all the glories and profits of an unstinted supply of artificial fuel gas; to which I reply, "May it be a true prophecy." We will have to wait, however,

for the verification. In its entirety, the address was well worthy the close attention paid to it by those who heard it read; and it will be well worth critical study when enshrined in cold type.

So far in the paper list, the palm must be awarded to Mr. Faben for his masterly treatment of the subject of "Fuel Gas." The Toledo gentleman's aversion to trusting too greatly to imagination was never more clearly illustrated than in the medium of his communication to-day to the liveliest Association of them all.

The list of honorary members was lengthened by the promotion of General Hickenlooper to a place thereon, and perhaps the meeting-room did not ring with acclaim when the announcement was made. I hope to forward you some further account to morrow. ***

CINCINNATI, May 16.—In accordance with my promise of yesterday I forward you something more from the seat of war. The weather continues fine, but the temperature is rapidly mounting. However, all are in good shape, and looking forward to this evening and to-morrow—the banquet hall being the attraction for to-night, with the steamboat outing on the Ohio, up to the East End station, and down to the Addyston pipe works, as the *piece de resistance* for Friday. Beyond a doubt the Western gas men are "pushers," and the Western Gas Association is pretty close to the top—"that's right." The second day brought in large additions to the audience and to the membership lists; I believe I said so in my bulletin of yesterday, but I shall have to repeat in this message—Ramsdell handles the gravel like a veteran, who is well up in manual; and Littleton cannot be exceeded as a Secretary—by the way, he was re-elected. To this I might add that the Association did itself credit and its Secretary justice by awarding him $400 per annum. The interest in the session was sustained to the last, and the verdict must be that it was one of the best meetings of the very many good ones that the Association can look back upon. The officers chosen were: President, E. J. King; First-Vice, C. R. Faben, Jr.; Second-Vice, Fred. Egner; Secretary, A. W. Littleton; Directors, J. B. Howard, E. H. Jenkins, Z. T. F. Runner, John Gimper, C. W. Butterworth, E. G. Cowdery, J. S. Ambrose, J. W. Dunbar and B. E. Chollar. St. Louis was selected as the next place for meeting. Judging from the preliminaries and the whisperings, the banquet will not be far from superb. In connection with the river trip to-morrow, I might explain that the steamer Thomas Sherlock has been engaged to take the members up the Ohio to the East End station of the Cincinnati Company. When the Hickenlooper stronghold has been looked over, the boat will go down stream to the Addyston Pipe and Steel works, from whence they will be returned to the city by means of special train. Please to jot it down in your notebook that Mr. W. S. Howell, of the Marmet Company, is what Chicago folks call a "dandy." ***

MENTION was made in our last of the recent successful inauguration, by the Winchester (Va.) Gas Light Company, of the Schuyler type of electric plant, installed for the purpose of meeting the desire of the authorities of that place for arc street lighting. The service since then has been satisfactory, and it may, we suppose, be taken for granted that Winchester is now at rest. A correspondent, in mentioning the circumstances connected with the turning on of the current, writes: "The time for lighting having arrived, and the streets being thronged with people impatiently waiting for the great event, at a few minutes after 8 P. M., little Ed. Baker, the eight-year old son of Mr. W. H. Baker, President of the Company, started the machinery, and the lights flashed out over the city amid the cheers of the populace. The procession then started. The members of our three fire companies, with full ranks, the steamers being handsomely decorated, preceded by bands of music and led by Col. Nulton's infantry company, marched through the streets in honor of the event, and under the glow of the electric arcs. Our citizens are much pleased with the light, and express themselves about it in enthusiastic terms."

AT the annual meeting of the Montclair (N. J.) Gas and Water Company, the following result was reached: President, J. J. H. Love; Vice-President, M. M. Dodd; Secretary and Treasurer, W. H. Baldwin; Directors, J. J. H. Love, G. Vanderpool, E. W. Langstroth, M. Plum, M. M. Dodd, A. B. Howe and S. W. Carey.

SOMETHING over a week ago, at a meeting of the St. Louis City Council, only one member being absent from his seat, Mr. Granahl enlivened the session by bringing before his colleagues a bill which aims to regulate gas prices in that city, from and after Jan. 1, 1890. Divested of its verboseness, the measure provides that after the date mentioned no gas company in that city shall charge in excess of $1.18¾ per thousand cubic feet, unless accounts remain unsettled for a period of 5 days after the presentation of the bills therefor, when the companies may collect $1.25 per thousand. A greater charge than the one specified is to be held as a misdemeanor. The Granahl proposition will not hold under the charter of St. Louis; at least so we are advised.

IN all likelihood from and after to-day the interests of the Norristown (Pa.) Gas Company and the Norristown Electric Light Company will cease to be antagonistic. In any event the stockholders of both companies are to vote upon a proposition for consolidation. Under the scheme we understand that the Gas Company will take up the electric stock, giving in exchange therefor an equal number of gas shares. Why this deal should be entered into—that is, by the Gas Company—is surprising, since even at the reduced gas rate ($1.60 per thousand) the Company was earning a handsome dividend. In any event, however, the electric investors have cause to be thankful that the present determination was reached.

R. N. OAKMAN, JR., of Greenfield, Mass., together with Burdett Loomis and Hawley Pettibone, of Hartford, Conn., and Hamilton Diston, of Philadelphia, have incorporated the Eastern Gas Machinery Company, of Hartford. They will start with $100,000 capital, but may increase that to $10,000,000. It is quite safe now to look for Diston wherever Loomis puts in an appearance. The latter, however, seems to be the pilot.

THE first result of the purchase of the Macon (Ga.) Gas and Water Company by those in interest in the Consumers Company is the establishment of an all-round rate of $1.50 per thousand cubic feet. Those who were enjoying the $1 war rate are clamoring loudly; but most gas men will agree with us that the new proprietors of Macon's gas supply have been very liberal. Gas is very cheap in Macon at the present rate; in fact, $1.75 would not be an illiberal figure.

SOME time ago the sub-committee of the gas committee of Philadelphia Councils were petitioned by numerous residents of the Twenty-ninth Ward to cause all the gas lamps on the streets surrounding the walls of Girard College to be relighted, urging in support of their claim the fact that the electric lights on the towers within the College grounds did not afford sufficient illumination for the protection and safety of the residents in the vicinity. It is thought that the petition will be granted.

A Coke Furnance.

The London *Journal* notes that the use of coke as fuel for steam-boilers, which is general in the majority of gas works in the United Kingdom, and in many other factories in British towns, appears to be a novelty in some parts of the Continent. At least, this is the only interpretation we can find for the proclamations that occasionally signalize attempts in this direction, as they are recorded in Continental technical journals. Perhaps this difference of practice may be traced to the divergency of the types of boilers favored in the country and abroad. The ordinary tubular boiler, so generally in use in England, with the furnace enclosed in the water space, may lend itself better to a non-flaming fuel than the plain cylindrical boilers with exterior fires principally used abroad. However this may be, on the occasion of the establishment of a third boiler in the Municipal gas works of Mannheim a new departure, signaled in the *Journal fur Gasbeleuchtung*, was made in the direction of adapting it to burn coke This boiler was in the form of three cylinders united by water legs, and wholly enclosed in a brick casing. The furnace was made deep, to accommodate a thick fire, and the iron plating of the boiler over the fire was protected by a tier of fire tiles, to prevent the direct contact of the gases of combustion with the metal. This had the effect of improving the combustion, by rendering the mixture of the carbonic oxide with the air more complete. The fire-bars are of plate iron, 8 inches thick, spaced an equal distance apart, and riveted together in threes. The fire and ash-pan doors shut air-tight. The air required for combustion is admitted by a channel opening at the back of the boiler setting, and comes to the front in a cast-iron pipe built underneath the bottom flue, where it gets heated to 100° C. by the waste gases. It rises in channels formed behind the front wall, and enters the ash-pit under the bars through openings in the side walls. A secondary supply of air at a higher level is brought in the same way from front to back, becoming heated by contact with the upper smoke flues, and meets the combustion gases just before the partition corresponding to the bridge in an ordinary furnace, at which point it has a temperature of 300° C. The ash-pan is kept full of water, and a steam jet is employed to keep clinkers from adhering to the fire-bars. Breeze is burnt in this furnace. The duty obtained is 9.65 of water per unit of fuel, which contains 10 per cent. of ashes and clinkers.

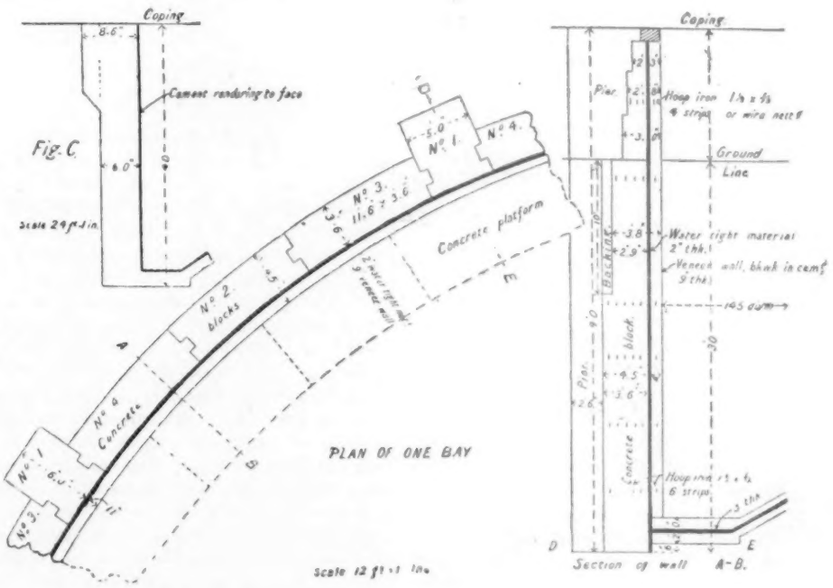
A New Departure in Tank Building.

By Mr. V. Wyatt.

[At the last meeting of the North of England Gas Managers' Association (held in Newcastle, April 27th) Mr. V. Wyatt read a paper on "A New Departure in Tank Building." Our report of the same is from the *London Journal*.]

Introduction.—I will commence my paper by reading a short extract from the preface to Ruskin's "Stones of Venice:" "On last Waterloo day I drove on to Brentford, and walked over Kew Bridge. I could not but be solemnly impressed by the appearance of a circular temple, built since I last crossed the bridge, some 30 or 40 times the size of that of Vesta, by the Tyber, which it otherwise in many particulars resembled, no less than that of the Sibyl at Tivoli. The dark walls and singularly tall and narrow columns rose sublimely against the twilight, at the extremity of the higher reach of the stream, and presented at once a monument to the art and the religion of the children of Thames; being no less beauteous a work of peace than the new gasometer of, I presume, the Brentford Gas Company, Limited. * * * Three days afterwards I was sleeping in the 'Greyhound Inn,' at Croydon, and my bedroom commanded, in the morning, what was once a very lovely view over the tower of Croydon Church to the woods of Beddington and Waddon. But no fewer than seven newly-erected manufacturing chimneys stood between me and the prospect; and the circular temple of the Croydon Gas Company adorned the center of the pastoral and sylvan scene." Observe, now comes the moral of the preachment, with its smiting counterblast. He continues: "There is not the remotest possibility of any success being obtained in any of the arts by a nation which thus delights itself in the defilement and degradation of all the best gifts of its God; which mimics the architecture of Christians, to promote the trade of poisoners; and imagines itself philosophical in substituting the worship of coal gas for that of Vesta." I thought that Vesta and Sibyl were goddesses peculiarly Roman and Pagan in their belongings, and had as much to do with Christianity as a chestnut horse with a horse-chestnut. The evolution of artificial light from a lump of coal by the intellect of man is much more one of "the best gifts of its God," than are those æsthetical vanities found in the gospel according to Ruskin; and which have to be taken mentally with a considerable "grain of salt." Take another sample brick from the same work, where he writes: "When I speak dictatorily and say this is base, degraded, or ugly, I mean that I believe men would either think it so, or would be prevented from thinking it so, only by some morbid condition of their minds." As much as to say, when people won't agree with you, throw at them the exclamation, "You are morbid!" or, as some superior persons would remark, "You have a defective organization." So preaches the apostle of dilettanteism against the gasholder and its originators, which preachment approximates to that of the author of the "Silver King," who says: "I hate practical men. It is the dreamer who rules the world; practical men only think they do." This is what Yankees call "asininity"—a term I recently met with in an American engineering paper. We, however, can live down this sort of thing, even at the expense of being thought morbid. If critics and hard words could break bones, what a lot of cripples we should be?

Ordinary Method of Tank Construction.—I will now speak of the gasholder appendage, commonly called the tank, and complete the temple which gas folks erect "to promote the trade of poisoners." Using the same constructive materials as of old (principally brickwork and concrete), permit me to suggest a few changes in the *modus operandi* of tank building, so as to save risk and economize work. The chief source of expense in making a tank lies in the construction of the sustaining ring-wall; and gas engineers are always scheming methods to perform this in the most expert fashion. It is usually effected by forming a circular trench of earthwork, of sufficient capacity to enclose the entire wall, with its piers and foundation platform—say, for moderately large tanks, about 30 ft. deep by 14 to 16 ft. wide, from *D* to *E* on plan and section of the sketches—and in this shield or cofferdam to construct the wall. The trench is strongly timbered by skilled men, in such form as to cover many weeks of risk, and insure perfect safety to the work going on, and the lives employed therein. The timbering alone of the trench costs as much as 3s. 6d. per cubic yard upon the actual net quantity of earth taken out of the same; or about 1s. 9d. per cubic yard, upon the entire excavation of the tank, including the cone; and sometimes, where water is met with, from 4d. to 8d. per cubic yard extra on the total excavation for the cost of pumping. The trench must remain a safe work, and resist all contingencies and cavings in of the sides, until the tank wall has grown into an accomplished fact. Some people there are who will be bold, and risk slips and heavy shoves of earthwork; and who meet the difficulty by merely sloping back the sides of the excavation, without timbering, and thus try to steal a chance of cheap success. But Nature will work her course. Exposure of the earth faces to atmosphere and moisture, swells the material; and the mass at times comes upon the half-finished wall like a miniature avalanche, playing havoc with everything, not even excluding the finances and the credit of the engineer. Supposing, however, that the wall be completed under this arrangement, by a close shave, with luck, and hurry-scurry work, the result too frequently is that, instead of the wall reposing against a solid, natural and undisturbed earth backing, consolidated by ages, the supporting material is artificially packed behind the wall, as "made earth;" and, being out of sight, is usually scamped, with resultant settlements, cavities, leaks, and changes of wall face.



Comparison of Methods of Construction.—We will suppose now, by way of comparison, that the wall is constructed in the open-timbered and continuous all-round earthwork trench, which is usually considered as the only safe method in the long run; and then compare it with the modification thereof which I am about to propose. Let us assume, by way of example, that we require a tank for a double-lift holder, to store a million cubic feet of gas, and we adopt a diameter of 145 ft. and a depth of 37½ ft. net, internal dimensions. Including the foundation, 30 ft. of the tank may be below, and 10 ft. above the ordinary ground level

of the site. This form of tank would necessitate, by the ordinary method of building, a timbered trench about 460 ft. in length, taken along the center line, by a breadth of 14 ft., so as to get in the full width of wall, piers and bottom level, 6 ft. wide to concrete foundation (see plan, *D* to *E*), which will enable the bricklayers to operate in front of the wall. I am assuming that the tank is built with a face of brickwork. Out of this heavily timbered trench, with its planked runners 3 in. thick, strong walings 11 in. and 9 in. by 3 in., struts 9 in. by 9 in., and props 4 in. by 4 in., we shall have to excavate at least 7,000 cubic yards of earth; and which will cost for the trench alone, on an average, everything included, about 6s. per cubic yard, even in earth of fairly good quality—say a total of £2,100. The trench ordinarily cubes up to about half the entire excavation of the tank. The timber in the trench requires twice fixing—viz., once to get out the excavation, and once again as the wall rises, to support the cone earth, the struts of the latter butting upon the green wall.

Suggested Method.—We will now consider another method of excavating the earth trench for the wall. Instead of adopting one large continuous trench, encircling the tank, and carrying with it the inevitable risks, let us suppose that the material be taken out in conveniently sized sections or blocks, separately timbered and completed for the concrete backing to wall, and of the form shown on the sketch plan of one panel of the tank, and numbered 1, 2, 3 and 4. The piers or counterforts, which carry the standards, are figured 1; each having an area of 6 ft. by 5 ft. for the concrete portions placed radially. These are performed first; and then the three closing-blocks between the pair of piers, figured 2, 3 and 4 on plan, each 11 ft. 6 in. by 3 ft. 6 in. in rotation. Here we have in the entire tank wall, up to the ground line, 48 manageable pits to deal with, instead of one large unwieldy circular trench 460 ft. by 14 ft. by 30 ft. By this mode of procedure the amount of earth to be excavated from the timbered trench is less than 2,000 cubic yards, instead of 7,000 yards by the previous method; being only about one-fourth, or just sufficient to enclose and get in the concrete for three-fourths of the ultimate tank wall. This can be performed at 2s. 6d. per cubic yard, including timbering and all expenses, and at a total cost of less than £250. Here is a saving on the trench excavation alone of £1,850, which, allowing £200 for the portion of cone included in the large trench, gives a net saving of £1,650, *plus* economy of time and plant, and avoidance of risk.

The pits or trenches are of small area, and only require light portable timbering, composed of polling boards, each about 3 ft. by 6 in. or 7 in. by 1½ in., cut out of rough stuff, placed next to the earth faces; with a tier of walings and returns 9 in. by 3 in. at every framing or setting of 3 ft. to 4 ft. in depth of the pit; and a single small strut (merely a short cutting from a larch pole) 4 or 5 in. in diameter, and about 2 ft. 9 in. long, driven in tightly against the walings. The polling boards, in place of the costly planked runners, can always be used to support the earth sides when the water-level is kept below the foundation of the inlet and outlet pipes for tank trench depths of 30 ft. No tank need go deeper than this into the natural ground, as the filling above can be arranged to meet the reception of the largest holders. A setting of timber is removed from the pit for each layer of concrete, which may have a depth of from 3 to 4 ft.; and, when completed, flushed and grouted on the top with fine stuff (1 to 3) and rammed well against the sides, the next layer of concrete is proceeded with by the removal of the next framing of timber above. The concrete thus deposited closes up at once to the clean, undisturbed faces of the trench, so as to retain in the earth its natural stability and cohesion, to uphold the wall and its full backing-up resistance against the bursting water pressure from the full tank. The top 10 ft. of the concrete wall is reduced by a set-off of 9 in.; and here portable wooden, collapsible shutters, in sections, are used to shape the back of the wall. These are left in position for a day or so, until the concrete has hardened, when selected earth-backing is substituted for the same, rammed in layers, and watered. Or for an extra expense of about £50, concrete of the full thickness, 3 ft. 6 in., can be carried up to within 3 ft. of the ground line, and "made earth" backing almost dispensed with. Each section or pit, when filled with concrete, forms one of the horizontal arch-blocks of the tank wall. The bottom concrete layer to each block, forming its foundation, about 3 to 4 ft. deep, needs no timbering, as this portion can be excavated and concreted in a few hours. The sections of wall marked 3 and 4 on plan to each bay are executed with safety, dispatch, and very little timbering; as, when the adjoining blocks (figured 1 and 2) are in place, they act as buttresses, and the earth pressure is largely removed from the trenches for 3 and 4. Operations can be going on at the same time to the four quarters of the tank, to give time for a rest of a week at least after completion, and to harden each block of concrete before closing in the adjoining ones. In setting out the tank, 4 in. extra should be given to the diameter, to allow for irregularities in the concrete face.

Previous Methods of Concreting Tanks.—I am quite aware that concrete tanks have been constructed by shooting concrete into an open, timbered, all-round, continuous trench, about 6 ft. wide, and corbelled out at the top to receive the holding-down bolts of the standards, as in figure *C*. The inside face of the wall was, when completed, rendered with cement and sand, and left with the face exposed to the elements. The corbel or overhang at the top (of about 2 ft. 6 in.) has a dangerous look about it, especially for concrete, and may splice off. The tank wall is necessarily bulky and overdone in material; and it has face water tight material, without the protection of a brick wall veneer face, which, I think, is very objectionable.

Water in Foundation.—Where water is met with in the trenches, it will be necessary to provide a sumpt or pumping hole, at a convenient spot outside the tank wall; and also to use one or two of the trenches for this purpose, before filling in the concrete. All sumpts should, as a rule, be from 5 to 10 ft. deeper than the foundation of the inlet and outlet pipes—the lowest part of the tank—so as to dry up the sides of the excavation in advance of the timbering. I have often thought, although I have never seen it carried out, that the best location for sinking a sumpt would be in the center of the tank, and through the cone, delivering the water from the pumps into shoots carried to the outside of the wall. This position would draw the water equally from all parts of the foundation.

Wall Sections.—The tank wall in this example is formed, as before stated, of 48 blocks of concrete, separately built, for a height of 30 feet, in the first instance; being the voussoirs or arch blocks, which, when completed and cemented together, constitute the horizontal arch or wall (acting similarly to the vertical arch), to uphold the earthwork behind. This anticipates future operations—such as the removal of the cone earthwork, the insertion of the concrete floor, the brick veneering and water-tighting to the concrete wall face, and the building up of the upper length entirely of brichwork to the tank wall 10 feet high above the ground level, as per section of wall *A B*, which is solidly backed up with made earth, rammed in layers 6 inches thick, and well watered.

Bonding Blocks.—As the blocks of concrete figured 1 and 2 on the plan are built, there will be left on their radial joints a notch on plan 1 ft. by 6 in., using a movable wooden template for this purpose; and this, when the sections 3 and 4 are closed in and finished, will bond and cement the arch blocks together in one compact whole.

Cost and Constituents of Concrete.—The concrete portion of the wall will cost from 10s. to 12s. per cubic yard, formed of one part of Portland cement, two parts of sand, two parts of gravel stones, and two parts of furnace clinkers and retort brick debris broken up into 2-in. cubes; the whole turned over three times dry, then mixed with water in volume equal to form one-fourth to one-fifth of the mass, according to season, and turned over twice when wetted from the rose-headed hose; and then thrown into the trench to be rammed in layers. Brickwork in Portland cement, to occupy the place of the concrete in the wall, would cost, usually, double the above value of concrete.

Hoop and Network Iron Bond.—Hoop iron 1½ in. by $\frac{1}{16}$ in. is placed at intervals of every 5 or 6 ft. in height of the wall sections; the strips placed at 6-in. centers on plan edgewise, and turned up at the ends to take up and unite with the strips corresponding in the closing blocks. Or, at the same intervals, place a network of ½-in. iron wires at 1-in. centers, meshed with lighter wires, and looped up at the ends to connect with adjoining blocks.

Clean Joints.—As each closing block is excavated, the radial joints of the adjoining ones are brushed and washed clean from all earthy matter to receive the fresh concrete.

Ventering, Water-Tighting, and Footing to Wall.—When taking out the earthwork for the cone, it is removed in convenient sections down to the top level of the tank platform, which is 2 ft. 6 in. above the wall foundation. After this those portions of the excavation at the foot and in front of the wall are taken out, alternately, apart from each other, and completed one section at a time, on the same day—as shown by the dotted lines on plan—to prevent any tendency, or kicking, of the wall inward. It is preferable to construct a rigid platform of concrete at the base of the tank wall, in sections, say, about 12 ft. by 6 ft. by 2 ft., and allow each to harden for a few days before the closers are formed; thus constituting, when completed, a horizontal solid ring all round the tank, to insure stability. When the floor and trenchwork concrete are completed, you can get at the face of the concrete hearting in the open daylight, to veneer and water-tight the same by building up a face wall of brickwork in cement mortar, 9 in. thick, say, four to six courses in height at a time all round the tank, 2 in. clear, on plan, in front of the

concrete face; or by a facing of concrete blocks, specially prepared and dried for a month in advance of the work, each 9 in. by 6 in. by 4½ in., weighing about 20 lbs., set also in cement mortar. Float into the 2-in. chase or cavity between the two walls a thick compo. paste or slurry, compounded of one and one-half parts of finely screened sand and one part of finely ground Portland cement, ground to pass 5,000 meshes to the square inch, thoroughly mixed with water, in layers 4½ to 6 in. deep all round the tank, slightly stirring up the same at first with a narrow tool to expel the air bubbles. As the compo. dries, but before it shows signs of hardening, gently stem or ram each layer, all round the ring, with a light rammer, scored on the underside to leave the chase surface rough, for keying into the next layer. Each time a course of watertight material is deposited in the chase the latter should be first well moistened (but not saturated) with water from a rose-headed jet. In fact, the whole of the tank materials should be kept well watered during construction; and as long as the moisture will disappear quickly into the body of the wall, and not flood the same, water, with cement and sand grout, can be used with advantage; so that when cold water is run into the tank at the finish a contraction and shock will not take place in the concrete wall, by inducing further chemical action and movement in the cement and sand. Watertight material, of cement and sand 1 to 1½, sandwich fashion, is also inclosed in the concrete and cone covering, 3 in. thick, and united to the wall chase, as shown on section of wall *A B*, so as to make the tank a complete watertight basin. This method of water-tighting is preferable to that of merely rendering the faces of the tank wall and cone with two or three coats of cement and sand plaster; for, as we all know, face cement rendering, like face puddle, or any other face watertight expedient, is not permanently weather and temperature proof; always moving minutely on its exposed face, refusing to combine with and key into the coarse materials beneath, developing hair lines and cracks for future leaks, and probably to peel off ultimately. No face work for tanks is better than a good, sound, vitrified brick wall, set in cement mortar, fronting and protecting the watertight material.

Composition of Water-Tight Material.—I may mention that it is an improvement to the water-tight compo. to use therein a pound or two of coarse, unrefined, black sugar to each bushel of cement—something like 1 to 2 per cent. by weight, of the cement used. The sugar slightly retards the setting of the cement, and tends to make the compo. tougher and somewhat glutinous. It is still further improved either by the addition of 1 lb. of course whole meal flour, or 1 lb. of what Scotchmen are largely compounded—oatmeal—to each bushel of cement, if you can afford it. Or take one part of furnace slag meal, ground to an impalpable powder, as manufactured and screened, it is said, to a mesh of 10,000 to a square inch (100 × 100); one and-a-half parts of fine sand, screened through a sieve of 1,600 meshes to the square inch (40 × 40), wires of same gauge as the mesh; one-tenth part of oxide of iron; and one part of fine Portland cement (5,000 meshes to the square inch) thoroughly mixed with a volume of water equal to about one-fourth of the solids, into a fluid compo. The free lime of the cement combines with the finely ground silica of the slag, and prevents the lime-juice from sweating through the wall.

Proportions of Tank Walls.—It must not be forgotten that in proportioning the thickness of the concrete wall backing, we must be governed by what is necessary to resist the external earth pressure when the tank is empty, and so as to ensure a working safety-factor of (say) 4 to the wall. Thus it may be taken as a safe rule, where the earth is fairly compact, that the mean thickness of the finished wall materials for the panels, between piers, should not be less than about one-tenth of the total height of the wall, for tanks up to 36 ft. in depth, with an inside diameter of 150 ft.; but for larger tanks, the mean thickness of the wall panels should be equal to one-eighth of the height. The piers or counterforts should have a thickness, radially, of not less than one-fifth, and a breadth of about one-seventh, of the total height of the wall. These proportions are based upon the assumption that brickwork and concrete in cement are the wall materials, and not in lime.

Advantages of Sectional Method of Building.—The sectional method of building tanks has the advantage of any other system where water is met with copiously in the foundations; and which may cost anything to pump out from 4d. to 8d. per cubic yard rated over the total excavation of the tank. It restricts the surface area for percolation. There need not be in operation at one time more than from four to six out of a total of 48 trenches. Thus should the pumps break down, the work could be stopped at once, and the resulting damages would be next to *nil*. The central cone of earth forms the shield to the wall blocks during construction and hardening; and the thrust of the earth upon the wall is arrested until completion, and the timber and plant are set free again and again to perform duty. The quantity of timber used for the trench work is not more than about 10 per cent. of what would be necessary for large, all-round trenches. You can sink and concrete one of these blocks in two or three days; and have the bottom portion of the same cut out quickly and sealed with concrete on the same day. There is no fear as to slips, cavings-in, jackings-up of timbers, cavities behind walls, and the other calamities which are incidental to the one all-round trench system. I have carried out this method of separate *versus* continuous trenchwork, so far as to use as many as 160 blocks of concrete to form the foundations for one superstructure of a building, and so limit the areas of difficult work, with an economy of time and material, as well as multiplying the work faces, and eliminating risk.

Importance of Natural-Earth Backing.—Most of the tank walls that have cracked after use, have probably been cursed with imperfect earth-backing; the natural soil having been taken out too fully from behind the wall, and substituted by loose stuff or no stuff at all; the earth faces too long exposed to moisture and air; and consequently the wall has been put under severe tensile strain from the bursting pressure of the tank water. All who have opened out the backs of tank walls to search for leaks, know painfully the honeycombings and cavities they have met with; and the proofs of the intense desire on the workman's part to scamp all work which will be covered up and out of sight, even when he is an "old hand," and is paid "daywork." Ordinary earths undisturbed—such as clay, marl, gravel, binding sand, etc.—will carry a safe load, without settlement, of from 2 to 5 tons per superficial foot of surface. Now, if we preserve this natural-earth resistance from lateral movements, by careful timbering and despatch in the trench, it will hold the wall free from all tensile or bursting strain from heads of water of 80 feet and upwards in the tank; or say 2 tons per superficial foot of surface at least. But if the backing behind the wall be made of earth, its resistance will be one-fourth of this.

The Radial or Arch Joint to Concrete Blocks.—The frequency of the radial joint in the tank wall, at the junctions of the concrete blocks, is not an evil, and it gives points of easement in the early periods of settlement, and prevents those shrinkage cracks so often visible on concrete walls formed in one monolith. This radial or arch joint is covered by the tenon or notch-bond shown on the plan; and also by the layers of hoop iron, used at 5-ft. intervals in height, running round the wall. I never knew a properly designed concrete wall, where hoop iron was judiciously introduced, which showed cracks on the face; and I never saw one built without hoop iron which exhibited a clean, uncracked exterior.

Summary.—To recapitulate. There are three motives in the present paper: 1. To construct the wall in trenches and sections of convenient sizes, instead of in one all-round trench, and in one monolithic block; thus insuring sound earth backing to the wall, safe wall settlements, a minimum of expense, plant, and risk, with expedition in the work. The sections, or blocks, when united, form the voussoirs of the horizontal arch, or retaining-ring wall of the tank. 2. The building of the face wall, with its compressed water-tight backing, in the open daylight, after the completion of the main or concrete portion of tank wall, because it is more easily performed and inspected than in the trench. 3. To maintain and preserve especially the stability of the natural earth as a backing to the wall, to resist the bursting water pressure of the full tank; leaving to the wall the sole duty of retaining the earth during construction. The wall material then is only strained in compression and not in tension. Brickwork and concrete in cement of the usual character combined in walls will take a maximum compressive strain of from 35 to 40 tons per square foot; but only a tensile strain of about one-tenth of this, or, say, 4 tons per square foot of wall sectional area. The maximum compressive strength of the tank wall in the example is equal to 12,000 tons; whereas its tensile strength is only 1,200 tons.

Formulæ.—The formula for the tensile strength of the tank wall is 2HCT=

2 walls × 37½ ft. × 4 tons × 4 ft.....	1,200 tons
The hoop-iron in wall + gravity of wall as a retaining wall = ¾ of above.....	900 "
Total.....	2,100 tons

The formula for the total bursting pressure from the water in the tank is DHP = 145 ft. × 37½ ft. × ½ ton = 2,718 tons. The bursting pressure is thus in excess of the maximum tensile strength of walls, although the latter have more than the usual thickness. We require here a factor of safety of 4, or a resistance of 2,718 × 4 = 10,872 tons. To obtain this, we must supplement the wall tensile strength by the earth backing or lateral support, equal to 10,872 − 2,100 = 8,772 tons. The earth backing

can be depended upon as a buttress to the extent of at least 2 tons per square foot of face *when its natural cohesion is preserved*, but as *made earth*, only one-fourth of this, and that not immediately. By the formula $D \times H \times 2$ tons$=145$ ft. $\times 37\frac{1}{2}$ ft. $\times 2=10,874$ tons, which, added to the 2,100 tons above for the tensile strength of wall, gives a total resistance of 12,974 tons to the wall and backing, or a factor of safety of $\frac{12,974}{2,718} = 4.77$, or nearly 5 to 1.

The formula for the maximum *compressive* strength of the two wall sections on opposite sides of tank is $2HTC^1=2 \times 37\frac{1}{2}$ ft. $\times 4$ ft. $\times 40$ tons$=$ 12,000 tons. Against this we have, when the tank is empty, the earth slope lateral pressure behind the wall, which may be taken, for ordinary *made earth* in a moist condition, as $\frac{2}{3}$ of the water pressure of the same height as bank$=2,718$ tons as above $\times 0.75=2,038\frac{1}{2}$ tons, and $\frac{12,000}{2,038} =$ a factor of safety of 5.88, or nearly 6.1 + gravity of wall.

C=Constant for tensile strength of wall=in example 40 tons per square foot of wall section.

C_1=Constant for *compressive* strength of wall=in example 40 tons per square foot of wall section.

D=Diameter of tank in feet=145 in example.

H=Height of wall above floor of tank$=37\frac{1}{2}$ ft.

P=Mean pressure of water per square foot of wall surface$=\frac{1}{2}$ ton in example.

T=Thickness (mean) of wall$=4$ ft.

Cost of Tank.—The cost of the tank, as per example, for a holder to store 1,000,000 cubic ft. of gas, at fair prices, would be £4 10s. 6d. per 1,000 cubic feet of storage, in average soil; and £4 16s. 6d. where water is met with copiously in foundation.

Mr. Wyatt exhibited a specimen of the fine sand he had referred to in the paper, remarking that he did not know why, but his morter was always best with fine, clean sand.

Discussion.

The President said that Mr. Wyatt's paper would be of very considerable interest to most of them. It was certainly not every day that a gas manager had a tank to construct; and for that reason, when he had one, he needed to fortify himself with all the experiences and hints as to construction that could possibly be obtained from brother managers. Personally, he had not had a great deal to do in the erection of concrete tanks, although he had used concrete for many other purposes; but he was a great advocate of concrete. He believed that, where the materials could be had at anything like a reasonable price, and where the circumstances were suitable, nothing better or cheaper could be used. Mr. Wyatt had brought out many points in his paper that, no doubt, would have their attention, and which, on carefully weighing them at their leisure, they should more fully appreciate.

Mr. R. Smith observed that he thought the paper so important that it was almost impossible to criticize it without having some time to consider it.

Mr. Wyatt remarked that it was too frequently thought by engineers that, the larger the work to be carried out, the cheaper it could be done. He had had a large experience in tank foundation pits; and he found that this was not always the case. He had found that he could make a small, manageable pit—say 6 ft. by 6 ft., by 10 yds. deep—cheaper than any other kind of pit, because they could do it quicker. A large pit required more timbering, as the earthwork was always coming in.

Mr. Watson asked Mr. Wyatt if he could tell them what took place when he mixed oatmeal with concrete, and how it improved it.

Mr. Wyatt replied that when they wanted to block a leak, they put in some fibrous material. The reason he suggested oatmeal, as well as sugar, was this—the sugar would run freely, but oatmeal had a certain amount of fibrous or glutinous tendency in it, which improved the cement. It only required 1 or 2 per cent.; and although it weakened the cement to that extent, it made it more watertight. He should not use it for brickwork. He had seen the contractors, when finishing the water works at Birmingham, ramming almost dry meal into the work. This he objected to, because, unless they gave a sufficient quantity of water to cement, it would never do its duty in setting; and when water afterward came though it was apt to produce cracks.

Mr. R. Bridge said he was very pleased with Mr. Wyatt's paper, and thought they were all much indebted to him for it. He should like Mr. Wyatt to tell them whether he had any difficulty in regard to the union of the sections in passing round the tank. If he understood rightly, one section was brought up from the foundation to the top; and then another section was commenced at the foundation. Was there any difficulty in the bonding or the union of the two sections, whether from the earth pressure at the back of the wall, or from the settling of the structure? Presumably the first section, after it was finished, would have settled somewhat into the foundation. The next section would also commence to settle, but not, he should say, at the same time as the first.

Mr. Wyatt said, in order to partly obviate that difficulty—although he should not do it himself—another notch could be put in the wall. They saw he put a notch in the radial joint, which gave him a key from top to bottom of 12 by 6. This held the radial arch like a key-stone; and consequently it could not come forward. The only question was as to going downwards; and concrete, after one week, never moved, except the foundation shifted. If cement moved—either expanded or contracted—they condemned it; but even if it did, they had a radial or tying tail-joint to keep it.

Mr. W. J. Warner agreed with all that Mr. Wyatt advanced, as far as the broad principle of construction was concerned. Some years ago, in putting down a couple of tanks at Jarrow, he laid down his plans almost upon the same principle. It appeared to him to be obvious that, in carrying up a structure in such a way, they were bound to have the work better done, firmer, and still giving points of easement, which, he quite agreed with Mr. Wyatt, were very necessary in every concrete structure. The vertical joint forming these easements, which he adopted at Jarrow, was scarcely the same as Mr. Wyatt's; inasmuch as he threw out a footing from each of the pillars, and made them somewhat wedge-shaped. These tanks were built in clay, and were therefore perfectly sound; and he did not think there was any fracture whatever in them. The concrete was put in in the usual way. He was afraid that, with reference to the iron bond, he was obliged to go into the opposite school. It was a point that was well debated a good many years ago; and he was inclined to trust to concrete itself to do its work. He would rather use, as he had always done, brickwork as a binding material rather than the concrete itself. He would certainly prefer, in that neighborhood, putting up the pillars of good, common firebrick, building them well in in cement, and then afterward filling in with the concrete between the pillars. He did not think there was any strict necessity for veneering the wall. It was an old principle—first used by Mr. King at Liverpool, where he excavated out of the solid rock. He himself had used it in connection with a rough rubble wall, in which case, he thought, it was an advantage. He would rather prefer to make an intervening space, or pocket, of asphalt. His method was to dip the bricks in hot tar, put them in place, and then fill in with tar behind. This was the only way, he found, by which he could resist water. He did this, he might say, after the tanks were put in. He was very much interested and pleased with Mr. Wyatt's paper, having worked somewhat on the same lines.

Mr. J. Hepworth said he could not help expressing his appreciation of the communication which had been laid before them. He was an old worker in concrete, both in the construction of gasholder tanks and reservoirs; but he thought he had learned something from the paper that morning. The general principles which Mr. Wyatt had set forth were such as would commend themselves to them all. There could be no question as to the utility of Mr. Wyatt's method, and the cheapness of a tank would be very much promoted by it. He was exceedingly interested in hearing Mr. Wyatt's description of his watertight material, because he himself clung to the prejudice of coating his tanks with pure cement, and relying upon that as the agent for preventing leakage. But the simplicity of the plan which Mr. Wyatt had suggested made it worthy of the attention of all of them. He was very glad to hear the reply given to Mr. Bridge. When the paper was being read he did not quite gather how the shrinkage was to be provided against; but Mr. Wyatt had now told them that in one direction there would be no shrinkage at all—that if there was in one way, it would strengthen the structure, and, if in the other way, it would be vertical; but it would not take place after the lapse of a week's time. The only point not clear to him then was whether Mr. Wyatt constructed the whole foundation of the sections between the pillars first; and if not, why not.?

Mr. Wyatt—Oh no; there is no communication whatever but what the pillars themselves give.

Mr. Hepworth thought that then, if they were working upon treacherous ground, they would have to make very special preparations for dealing with the surrounding earthwork, when they were constructing the uprights. Mr. Wyatt's experience was so much larger than theirs that he might tell them whether, in the event of a shifty foundation, there was any need whatever to risk that, or whether he would simply go on building his base, then trough it, and go on with the next section—trusting, in the same way, to the weight of the material finding its own base. It was a pity that this subject could not be taken up at a

subsequent meeting—seeing that the paper had not been submitted to them in print before the meeting. He did not think there was anything more that he could add to the discussion, but nothing could increase the gratitude which he felt to Mr. Wyatt for that day, as in times past, bringing before them a paper upon constructive work.

Mr. Wyatt replied that, when they dug down to the depth they had to go, they invariably met with a material upon which they could place a heavy weight. The only thing they had to avoid was water; but, as he had pointed out, if they pumped they would find a dry foundation. They might put upon ballast an almost incredible weight, because at such a depth it became so compact that no reasonable weight they could put upon it would ever compress it. They could not alter the form of the block after it was set. It had assumed a form and a shape which would never change; and the new cement put in at the sides would form a bond to it. It was not correct to say that iron and cement would not go together, because he had tested it for compression strain, and he could get four times the duty of concrete, at an expense of about one-fourth the cost. But, in addition, the iron gave it a tensile strength. It seemed to develop the strength of the concrete, though they could not tell how it did so.

The President, in closing the discussion, said he would just add some strange experiences he had had with asphalting and concrete. In his earlier days he was located in the neighborhood of Low Moor; and one day when they were making asphalt a workman suggested that he might take some of the "rolling sweepings" and put them into the asphalt. He put in three or four shovelfuls, and it resulted not only in the asphalt setting very much quicker, but, when it had set, it was almost like iron itself—it was next to impossible to get a pick into it. The idea occurred to him, in making concrete, that he might with advantage do the same thing; and he tried it with almost the same result. He could to some extent diminish the quantity of cement used; and he obtained a considerably harder cement, which would stand a good deal more strain. He merely mentioned this because he knew that many of them could not have the opportunity of doing it, as he had. It was certainly used with very great advantge. He had no doubt they would all agree with him that Mr. Wyatt in his paper had put matters before them which would not only be of advantage to them just now, but which would be of very great benefit to them in times of extension, either in the way of tank building or in erections in which concrete was required; and for this reason he had very great pleasure in proposing that the best thanks of the meeting be given to Mr. Wyatt for his very able paper.

The proposal was heartily agreed to.

Methods of Testing the Resistance of Certain Building Materials.

M. Leon Durand Claye thus treats this subject: Three methods are employed in these tests, namely, compression or crushing, tension or tearing asunder, and flexion. In the first method, the test-blocks are cubes or rectangular prisms with square ends, which are placed between two plates, to which the compression is applied by a lever or hydraulic press. Tensional strains are applied by gripping the two T-shaped ends of the test-block in jaws which are pulled in opposite directions by means generally of levers. Lastly, flexional tests are made on prismatic bars, whose ends rest on knife-edges, and have a strain imposed at the center, either by loading a plate suspended on a knife-edge, or by means of levers. Compression is mainly used in testing stones, and tension for limes, cements and mortars; whilst it is not usual to test by flexion in a regular manner. These three methods of testing do not give at all identical co-efficients of resistance; and the results by any one method vary according to the form of the test-blocks.

Compression.—The crushing pressure P, under which a material under compression gives way, divided by the sectional area S of the block, gives the resistance to compression per unit of bearing surface. The block, however, is not wholly crushed; but it fails by the formation of cracks, and the occurrence of slidings in the plane of these cracks. When a prism with a square base is employed, having a height more than double the length of a side of the base, a single crack is generally produced, with its plane following a slope of about $\frac{1}{2}$ to 1, which accords with theory. The compression test, therefore, measures the resistance to shearing, which approximates to a quarter of the mean compressional breaking strain, in the materials under consideration. When the material is homogeneous, and the pressure is very uniformly distributed, the symmetry of the arrangement leads to the formation of two cracks, starting from the sides at the top, and converging towards the center of the block, leaving a central wedged-shaped mass which tends to split down the lower part of the block into two parts, with a central vertical crack. In other cases, the two upper cracks extend down, forming a second wedge below pointing upwards, and dislocating the sides; or, if the uniformity of the material and pressure is perfect, the wedges become prisms. When the blocks are cubes, the cracks, starting from top and bottom, sometimes form two truncated pyramids separated by a central horizontal crack; but more often one crack follows the diagonal, and the two cracks from the two remaining corners, meeting it, divide the block into four triangular fragments. In the case of homogeneous material and uniformly distributed pressure, fragments fall off from the sides; and the two oblique pyramids freed by the cracks slide along the diagonal crack. From the above observations, it is evident that the resistance to crushing, $\frac{P}{S}$, varies with the form given to the blocks, and that the results of experiments with different materials are not comparable unless the forms of the test-blocks are the same. The cube is the simplest and most easily prepared form.

Tension.—In the earlier experiments of the Ecole des Ponts et Chaussees, the T-shaped briquettes had their inner angles rounded off by curves, and a central section of $2\frac{1}{2}$ square inches; but this was modified, about 1876, by substituting straight lines across the angles for the curves, increasing the solidity of this part, but retaining the same central section. At the present day, all operators in Europe adopt the German form of briquette, of similar types, widening out to a rounded form at each end, and with a narrow contraction in the center, having a sectional area of $\frac{3}{4}$ square inch. The ratio $\frac{T}{S}$ is only the average tensional breaking strain, and not the limit of resistance of the material; for rupture occurs when the limit of resistance is reached at any one point of the section. The strain, indeed, is greater at the outside than in the center of the section, as indicated experimentally in the laboratory of the Ecole des Ponts et Chaussees. Briquettes of india rubber, with lines drawn on them perpendicular to the axis, were stretched; and the curves assumed by the lines showed plainly the greater strain towards the outside. Two series of similar briquettes were next made with the same mixture of cement, one set having a hole left in the center of the section, and the other set with the hole at the side; and the breaking-strain averaged 576 pounds per square inch in the first case, and 485 pounds in the second. Lastly, briquettes were made 1.57 inch wide; and in one set, the central portion, 0.78 inch in width, was made of mortar, and the other portions of neat cement; whilst in another set, the materials were reversed. Thus the sectional areas of the mortar and cement were equal in both cases, but their positions altered; and the average breaking-strain of the first set was 301 pounds per square inch, and of the second set 261 pounds. It is proved, analytically, that the larger briquettes have a smaller proportionate breaking-strain—a well-known fact, but not previously explained. The distribution of the tensions also depends on the form of the briquette, as is readily perceived from an inspection of the different curves assumed by the lines on the india-rubber models under the same tension. The difference in the curves of the same india-rubber model, when different jaws were used, shows that the form of the jaws also has some influence on the distribution of pressures. It is clear, therefore, that comparable results can only be obtained with briquettes of the same section and shape, clasped by similar jaws, which explains the frequent apparent discrepancies in results of experiments. The advantages of the German form of briquette are, that its small size enables several to be made with the same mixture of cement, and that rupture can only occur in the contracted central portion; whereas, in the other forms, rupture does not always take place in the minimum central section, in which case the conditions are somewhat modified.

Flexion.—Tests by flexion are rarely resorted to, though the materials are often subjected to such strains. This is due to the necessity of interpreting the results by help of calculations, instead of obtaining them by simple observation as in the preceding methods. With a rectangular prism of height h, breadth b, and length l between its supports, loaded with a weight W at its center, and having a weight w per unit of length, the maxima tension and compression on the bottom and top fibres respectively, are represented by the formula,

$$R = \frac{3l}{2b}\,\frac{W + \frac{1}{2}wl}{hb}$$

This formula is, however, only applicable to materials which elongate proportionally to the tensions up to the moment of rupture. This is true for the top fibres in compression of the materials under consideration; but the bottom fibres, being in tension, give way first; and for some of these fibres, which have passed the limit of elasticity at the moment of rupture, the formula is no longer applicable. The modulus of elasticity of various building materials, subjected to compression, has been determined in the laboratory of the Ecole des Ponts et Chaussees; but the

tensional breaking weight is so small that it is impossible to ascertain directly the corresponding elongations. Diagrams, however, are given, showing the results of the measurement of the deflection of prisms of the materials under increasing loads, where the loads are taken as the abscissas, and the deflections as the ordinates. As long as the limit of elasticity is not passed, the locus is a straight line, but becomes a curve concave upwards beyond this limit; and it is evident from the diagrams that, for the materials under consideration, the limit is reached considerably before the breaking strain. It follows that the resistance deduced from the formula at the moment of rupture is greater than the real limit of resistance, so that the results derived by the ordinary formula of elas ticity from the flexional tests are too high. The coefficient for deducing the real limit of resistance from the calculated limit, can be found by investigating the curve of flexion; but the calculations are complicated, and the operations and measurements are delicate. Nevertheless, by reducing the dimensions of the test-bars, and merely measuring the breaking load, comparable results are obtained with bars of exactly the same form; and this method of testing is as reliable as tension tests, and more simple, owing to the greater simplicity of the manufacture of the test-bars, and of the machinery employed for testing. The author has made a large number of experiments with bars, 0.78 inches square, of various cements, placed on supports 5.94 inches apart, which gave as regular results as briquettes subject to tension. Any one of the three methods may be employed for comparing the resistance of the several materials, but none of the methods give the absolute resistance of the materials. In experimenting upon molded materials, such as limes, cements and mortars, it is essential that the specimens should be prepared under identical conditions in respect of proportion of water, duration and extent of mixing, temperature, compression in the molds, etc., so that really few experiments are comparable, except those made in the same laboratory, by the same persons, and with the same precautions.

Abstract from Annual Report, City Gas Works, Richmond, Va.

We are indebted to Superintendent W. C. Adams for a copy of his report covering his administration of the Richmond City Gas Works for the twelvemonth ended Dec. 31, 1888. We make the following abstracts:

By reference to the figures it will be seen that there has been consumed for the use of the city 41,094,299 cubic feet of gas. The statement of gas generated shows that 185,534,500 cubic feet were made, showing an increase over the corresponding period of 6,425,900 cubic feet.

At the date of last report there were 1,465 street lamps; there have been added during the year 53, making a total of 1,518, located as follows: First District, 468; Second District, 457; Third District, 543; First Market, 16; Second Market, 14; Upper Works, 5; Lower Works, 15—total, 1,518.

The receipts and disbursements, on account of current expenses, are as follows:

Received for gas		$188,801 25
Received for coke, etc		22,643 25
		$211,444 50
Disbursed for pay-rolls	$80,679 60	
Disbursed for coal	63,579 19	
Disbursed for expenses	8,456 76	
		152,713 55
Excess of receipts over expenditures		$59,730 95
To which must be added 41,094,299 cubic feet of gas consumed by street lamps and public buildings, at $1.50 per thousand feet		61,641 44
Total in favor of the works		$121,372 39

The maximum production of gas in any one 24 hours occurred on the 20th of December, which was 802,700 cubic feet.

The maximum consumption of gas in any one 24 hours occurred on the 22d of December, amounting to 753,277 cubic feet.

At the date of last report street mains measured as follows: 60 miles 1,515 feet; laid during the year, 13,709 feet—making a total to date of 62 miles 4,664 feet. There have been put in for new consumers 177 service pipes; renewed and repaired, 554 services of various sizes in different sections of the city; removed 22 lamps to accommodate alterations in grade of streets; and repaired a very large number of leaks and breaks in main pipes in different parts of the city.

I would again call your attention to the urgent necessity of increasing our holder capacity. We have been exceedingly fortunate in getting through the present winter without any serious inconveniences, but we cannot reasonably expect, with the constant growing demand for gas, to pass another winter so easily with the same capacity. At the height of demand more gas is consumed than it is possible for us to store. Had an accident happened whereby either one of our holders would be thrown out of use, the inevitable result would have been that a portion of the city would be in darkness. I wish to guard against the possibility of such a thing occurring, and it is with some degree of earnestness that I urge an additional holder of 750,000 cubic feet capacity to be located in the west end of the city.

The adoption of the means of giving us an increased manufacturing capacity will enable us to make at least 1,250,000 cubic feet per day. This improvement is progressing as rapidly as we could reasonably expect, and will be completed by the middle of March. I would further suggest as a means of giving us a still greater capacity, to remove the old benches of 5's, and substitute in their place improved benches of 6's. This can be done without an additional building, and at a cost of about $12,000. By making this change the work on the men will be more uniform, and the production of gas very much cheapened, besides giving us a daily capacity of 1,500,000 feet.

I would also call your attention to our limited purifying capacity. While we have no serious trouble or inconvenience thus far, I am free to say it is a matter that should be considered in time, as this is one of the most important departments in the manufacture of gas. You well remember the very serious inconvenience and annoyance our citizens were subjected to a few years ago from impure gas by reason of not having sufficient purifying surface.

In closing this report it affords very great pleasure to express the very high appreciation I have for the valuable aid and co-operation rendered me by the Committee on Light in the management of these works, and with the expenditures under their management of a few thousand dollars more we will have a plant that every citizen can point to with pleasure and pride.

The officers and employees have been diligent and efficient in the discharge of their respective duties, and to them I am indebted for their hearty co-operation and aid.

The Production of Gas in Denmark.

The following particulars respecting the manufacture and sale of gas in Denmark are from a Danish authority:

Copenhagen is the only capital which has built its gas works for its own account, and there are also, so far, but few capitals which own their gas works. Neither London, Paris, Berlin, Munich, Vienna, Amsterdam, Brussels, nor St. Petersburg are themselves gas producers. During the years 1853-4 the English "Danish Gas Company" built 8 gas works in Denmark (Odeuse, Aarhus, Elsinore, Aalborg, Viborg, Randers, Veile, and Flensburg), and in 1860 one at Frederiksberg—a large suburb of Copenhagen. These works represent about the whole of what has been built by private initiative; there are now in Denmark altogether 36 gas works, of which 8 belong to the English Danish Company, one belongs to a Danish company, and the remaining 27 are the property of the respective corporations.

During the year 1886, the total production of gas in Denmark amounted to 980,631,720 cubic feet, of which 594,517,000 cubic feet came from the Copenhagen gas works. The production of gas is steadily increasing, being only 705,731,600 cubic feet in the year 1881. The increase is largest in the towns where the gas works belong to the English company, as they have done much in various ways to encourage the use of gas for heating and cooking, for which purposes the price of gas was reduced as far back as 1882-83. The largest yearly consumption of gas per individual is in the town of Nakskov, with 4,400 cubic feet per each person. Otherwise the consumption varies between 1,000 and 2,000 cubic feet for each person. For comparison we append the figures from a few large towns with heavy consumption, viz., Birmingham, 7,366 cubic feet; London, 5,938; Paris, 4,591; Vienna, 3,841; and Berlin, 2,806 cubic feet per individual per year. For public lighting about 98,000,000 cubic feet are used in all Denmark, and the gas lamps amount to 6,832 in the twenty-seven towns with their own gas works. The coal consumption at all Danish gas works amounted in 1886 to 98,271 tons, costing rather more than $339,000, the coke produced realizing about $262,000. The total value at which all the gas works in Denmark are booked amounts to about $4,000,000.

The proportion between the consumption of gas for lighting and cooking purposes varies greatly in the different towns; in two small towns,

where cooking gas has been cheaper than lighting gas for more than 20 years, the consumption of the former has been proportionately very large; in one town the consumption of cooking gas was in 1887 more than twice that of gas for lighting purposes. The average sale of cooking gas in these 27 towns, where there are different prices for cooking and lighting gas, is about 27 per cent. of the total sale of gas, whereas it only amounts to 10 per cent. of the consumption for the whole country. These few figures, not very important in themselves, tend to show very distinctly what a wide field for gas consumption cooking and heating may afford (only it appears to want some cultivating), a circumstance which may be able to counteract the competition of the electric light, which, so far as Denmark is concerned, is heavily handicapped by the many corporation gas works.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE authorities at Alexandria, Va., have at last decided to improve the gas works. This decision involves the construction of an additional gasholder, to have storage capacity for 125,000 cubic feet. The new vessel will occupy the site of the holder that was first constructed at this point, in the spring of 1853. In the meantime the consumers will have to depend on holder No. 2 for a supply of gas, and as the capacity of that is not in excess of 30 per cent. of the daily sendout, it is likely that the distribution of gas in Alexandria during the ensuing three months (it is thought that the new holder will be completed by August 15th) will be accompanied by many an erratic happening.

AT the annual meeting of the East End Gas Company, Pittsburgh, Pa., the following officers were chosen: President, W. H. Denniston; Treasurer, Geo. A. Berry; Secretary, O. S. McElroy; Directors, H. Van Vorhis, H. Depuy, S. J. Wainwright, Jas. S. McCord, and Geo. Finley.

IT is rumored that General Hickenlooper will soon rebuild the West End Station of the Cincinnati Gas Light and Coke Company. This, of course, means that as the East End is so shall the West End be. Our authority for this surmise also adds that the work will involve an expenditure of $500,000, and that that sum shall be raised by an issue of new stock, to holders of record, at par. What a neat concession is thus involved will be readily understood when it is noted that a week ago the ruling rate for Cincinnati gas was 216½. The latter, by the way, is an advance of 11 points over the last authentic quotation received by us, and which appeared in our issue for April 8. It is presumed that the showing made by the last annual report is to be held accountable for this sharp increase in value. When the field has been thoroughly looked over, one cannot help believing that Cincinnati gas stock is a much better article to hold than any of the many varieties of Cincinnati electric lighting shares.

AT the annual meeting of the Wilmington (N. C.) Gas Light Company the reports were quite satisfactory to the shareholders; as indeed they should be, since a pronounced increase in the Company's business was proclaimed by the figures presented. The universal expression of regret at the death of Geo. R. French, Sr., late a Director in the Company, showed how greatly that excellent gentleman had been esteemed by his associates. The annual election resulted as follows: President, E. S. Martin; Secretary and Treasurer, R. J. Jones; Superintendent, J. W. Reilly; Directors, Donald MacRae, Dr. A. J. De Rossett, Capt. Jno. F. Divine, E. S. Martin, G. H. Smith, G. W. Kidder and Geo. R. French—the latter is a son of the late G. R. French, Sr. Other than the substitution above noted, the list is identical with that of a twelvemonth ago.

AS noted in our market report of a week ago, no change was made in the Board of Directors of the Cincinnati Gas Light and Coke Company at the annual meeting, held a fortnight ago. The Directors are: Gen. A. Hickenlooper and Messrs. A. D. Bullock, George Wilshire, Robt. Allison, T. D. Lincoln, Joshua H. Bates and W. A. Goodman.

THE contract for the new purifying apparatus for the Louisville Gas Light Company has been awarded to the Bouton Foundry Company.

THE following notice, which bears the signatures of the executive management of the Laclede Gas Light Company, explains itself: "Office of the Laclede Gas Light Company, May 8, 1889.—A meeting of the stockholders of the Laclede Gas Light Company will be held at the office on Wednesday, July 10, at 9 o'clock A.M., to consider and determine all questions concerning the acquisition by this Company, by purchase or otherwise, of any or all of the certificates, stocks, bonds, rights, franchises, and property of any and every kind of the St. Louis Gas Trust, the St. Louis Gas Light Company, the St. Louis Gas, Fuel and Power Company, and the Carondelet Gas Light Company, or either of them, and also to increase the capital stock of this Company from $2,500,000, the amount of the present capital stock, to $10,000,000, and to issue its first mortgage gold bonds to the amount of $10,000,000, and also to order the entire present stock of this Company to be a second lien or preferred stock, subject only to said bonds that may be issued on all its property and net income to the amount of 5 per cent. per annum, payable semi-annually or quarterly; and generally to consider all and every matter that may be brought before the meeting of the stockholders."

AT a recent meeting of the proprietors of the Manitoba (B. C.) Electric and Gas Light Company, it was resolved to approve the action of the Directors, who had ordered the installation of an incandescent electric lighting plant. Manager Bathgate says that the system will be in operation about July 15th.

MR. AND MRS. FRANK SEAVERNS will ascend the Eiffel tower this summer. They sail for Europe, per the Cunard line, from this port on Saturday next.

BUSY Geo. F. Kreischer, of this city, will also indulge in the luxury of an ocean voyage. He proposes to escort his family to the other side, where they will enjoy a season's rambling. Meanwhile the head of the family will return to New York, under sealed orders, which, when opened, will likely order him back to Europe in the fall for the purpose of leading home his happy flock.

NEXT month the Portsmouth (N. H.) local electric lighting plant will be transferred to the gas works station. The change will result in substantial economies.

MR. WM. HIGGINS, Secretary of State, Topeka, Kas., calls attention to the fact that proposals will be received at his office, until noon, 29th inst., from contractors for all necessary wiring or fixtures for the lighting of the east and west wings of the State Capitol building with electric light or gas. The contract will run for two years from July 1, 1889. The proposals will be opened by the Executive Council, at its regular meeting, to be held on the afternoon of the 29th inst. Although Secretary Higgins invites proposals for a problematical gas supply, it seems to us that his invitation in this respect is not characterized by candor; for it is well known to those behind the throne in Topeka State House matters that the present is a case of electricity or nothing for lighting the aforesaid "east and west wings."

AT the organization meeting of the Directors of the Derby Gas Company, of Birmingham, Conn., Mr. Wm. B. Wooster was re-elected President, and Mr. Chas. H. Nettleton was again returned to the triple position of Treasurer, Agent, and Engineer. The Company prospers in a pleasingly progressive ratio.

THE offices of the Athol (Mass.) Gas Company have been removed to handsome quarters in what is known as Lord's block, Exchange street. The equipment of the place is at once artistic and common sense.

MR. C. S. J. RUGGLES, the recently appointed Superintendent of the Gardner (Mass.) Company, is meeting with great success in his new field.

THE North Adams (Mass.) *News* gravely announces that the tank (*sic*) for the "new Williamstown Gas Company could not be brought through the Hoosac tunnel because of its size; hence it was necessary to ship it by a circuitous route." Well! Well!

AS was intimated in the JOURNAL some time ago, the proprietors of the Putnam (Conn.) Gas Company and the Putnam Electric Light Company have carried out the proposed scheme of amalgamation, and the interests of each division no longer conflict. In the new organization it would seem as though the electric end of the consideration were in the ascendant, judging from the fact that F. W. Perry was chosen President, Mr. A. W. Bowen having been appointed Secretary, Treasurer, and Superintendent. The old gas interest, however, is pretty well represented in the Board of Directors, the personnel of the same being Messrs. A. Houghton, F. W. Perry, James W. Manning, Charles E. Searles, S. H. Seward, A. W. Bowen, and G. A. Hammond. The Company is to be known as the Putnam Light and Power Company, and the electric annex is to be installed on the gas works plot.

THE present proprietors of the Cottage City (Mass.) Gas and Electric Light Company do not seem to be in any great hurry over starting up their property recently acquired through foreclosure sale. They will, however, be obliged to speedily make up their minds, as the unusually warm May that has thus far been the portion this year of dwellers along the East Atlantic coast has caused the owners of "cottages by the sea" to get ready thus early for their summer occupancy.

AT the annual meeting of the Conshohocken (Pa.) Gas and Water Company the following officers were elected: President, J. Lukens; Secretary and Treasurer, Alfred Craft; Directors, L. A. Lukens, E. D. Jones, Alan Wood, Jr., William Summers, Sr., and Howard Wood. The annual reports were satisfactory.

WE are in receipt of the annual catalogue of the Wilbraham Brothers, of Philadelphia, whose well-known specialties are in such repute as to require no words of commendation from us. That the Baker system of blowers and exhausters (the sole right to manufacture which in this country is held by the Messrs. Wilbraham) finds favor with our gas makers is best shown in the evidence afforded by the catalogue. For instance, in respect to the satisfaction that is given by the working of their exhausters at different points of location, we may note that fourteen testimonials are afforded, every one of which was written in the month of April last. In the blower branch of their trade we note that twenty-two gas companies operating water gas plants have installed the Baker type of apparatus.

THE Hamilton (O.) Council, having determined to operate a municipal gas works under the authority recently conferred, is in somewhat of a quandary as to how to begin. The outcome of the primal rumination seems to have been the appointment of a Board of Gas Works Trustees, to consist of three members, the compensation of each to be $500 per annum, "during the construction of the works," each to file a bond of $25,000. We wonder what compensation the Trustees will manage to secure during the "operation" of the works. It is not now, but then!

IN connection with this project at Hamilton, we might further mention that Mr. Jas. R. Smedberg has been consulted by the authorities, who empowered him to furnish plans and estimates for the works, which would satisfy their longings. The result of his researches—and most engineers will probably agree to it, that if the Hamilton estimator were given *carte blanche* he would give the authorities a modern gas plant—told very nearly in his own words, is as follows—please to note the pleasant way in which Mr. Smedberg alludes to the Hamilton gas works projectors: "With the advantages of site and transportation, and, further than these, of the skillful attributes of the gentlemen with whom I have been brought in contact, the first section of the city's gas works will be the best in equipment and the cheapest as to manipulation of any in the country. The manufacturing and registering plant will occupy a strip extending 200 feet from Third street to Lowell street, with a width of 80 feet: This property immediately adjoins the pump house of the water works, and extends northwardly to Old river, consequently there will be left of property belonging to the city more than one-half an acre for extensions. The gas-holders are to be located on adjoining property, and the whole is to be of modern construction, with powers both of manufacturing and delivering, of 200,000 cu. ft. per diem, or 70,000,000 cu. ft. a year. The footings of the estimate are slightly within the bonded limit of $150,000, and I am prepared to give bond in the sum of $100,000 that a perfect station of the capacity mentioned shall be built within the footings of my estimate; and while the pipe line is an expensive one, and although cheaper station works might be built, the whole work as projected, looks only to the pivotal result of the cost of gas as delivered to the consumer. When this first section is running to its full capacity it will pay fixed charges and deliver gas to the citizens at $1 per 1,000 cu. ft., and light the streets at $10 per post per year. Meanwhile space is reserved for a section, to have double the capacity of that already arranged for. Beyond purely trifling expenditure for architectural decoration on the Third street front, not a penny is to be spent in the construction of the works for luxuries. As to the pipe line, the calibers are such throughout its 30 miles of extent as to deliver the present output of the Dayton Gas Company with a uniform and satisfactory pressure. This pipe line is divided as follows: 2 miles of 12-inch pipe; 3½ miles of 8-inch pipe; 2½ miles of 6-inch; and 22 miles of 4-inch. Judging from this outline Hamilton means to have a good service; even if it does come high.

THE Jamaica Plain (a suburb of Boston) residents are inquiring why they, who live in the portion of the Third Boston ward, south and west of Sheridan avenue, are obliged to pay $2.50 per 1,000 (gross) for gas, while those who live north and east of the line mentioned have to pay but $1.25. The Bay State Company may have opportunity to solve the problem, later on.

ABOUT 10 days ago the Lima (O.) Gas Light Company brought suit against the city for an unpaid gas account amounting in value to $5,400. On June 4, 1884, the city entered into a contract with the Gas Company, under which the latter was to supply gas to the street lamps, until June, 1894, at a charge of $2.75 per 1,000. On Jan. 1, 1886, the Company voluntarily agreed to reduce the rate to $2 per 1,000, provided a contract for the supply, to last 9 years from that date, be granted. This was agreed to. On April 1, 1888, the Council notified the Gas Company that the contract was abrogated, and the authorities contracted for the street lighting with the local electric lighting company, the latter indemnifying the city by a guarantee bond against any damages the city might be subjected to because of its breach of contract with the Gas Company. The latter continued to light the gas lamps, but as the Council refused to allow the Company's bills, this suit was brought. It seems to us that the complainants have a sure case, and in any event it behooves the city to look closely into the solvency of the signers of the bond.

THE purchasers of the Cottage City Gas and Electric Company have capitalized their purchase in $25,000. Mr. H. A. Holcomb has been elected President, and Mr. J. A Brownell will act as Secretary and Treasurer.

THE Committee on Manufactures, Massachusetts Legislature, has made a unanimous report on a bill to authorize the authorities of Danvers to supply the inhabitants with electric light and power. The authorized expenditure for plant installation is not to exceed $15,000, which may be raised by the sale of 30-year bonds, to bear 4 per cent. interest. The works are to be carried on by a Board of Electric Light Commissioners, to be elected at the annual meeting of the town. Any net surplus is to be paid into a sinking fund for the redemption of the bonds, and the town management of the plant is to be under the supervision of the Board of Gas Commissioners. The complete legalization of the scheme depends upon the acceptance thereof by a two-thirds vote of the rate-payers.

ON the morning of May 7, an explosion, that destroyed the roof of the generating room, occurred in the producer gas plant operated in connection with the general plant of the Calumet Iron and Steel Company, located in Cummings—a suburb of Chicago. Defective tubing is said to have been responsible for the affair. Loss, about $1,000.

WE regret to chronicle the death, on the 8th inst., of Mr. Frank Neely, late President of the Waterloo (Iowa) Gas and Electric Light Company. Deceased, who was also President of the Waterloo Equitable Insurance Company, was a prominent lumber operator, and had been P. G. C. of the Knights Templar of Iowa. He was a native of Belvidere, Ills., but had for many years been identified with Waterloo and its best interests.

THE Massachusetts Senate, without a word in dissent, accepted the adverse report of its Committee on Manufactures in respect to the proposition to authorize the operation of gas companies on municipal account.

AT the annual meeting of the Millville (N. J.) Gas Company, the stockholders were surprised and pleased by the declaration of a 5 per cent. dividend. The following Directors were elected: Geo. B. Langley, Geo. Wood, Walter Wood, W. D. Kemble and Francis Reeves.

THE North Adams (Mass.) Gas Company has offered to perform the public lighting on the following basis: Full power arcs—from 20 up to 120—to burn until midnight, for $72 each per annum, the gas lamps to be put in duty on the extinction of the arcs, $12 per post per annum to be charged for the eking-out service. The electric light company offered to maintain 65 arcs for a total annual payment of $7,475, or $115 per annum each. The matter was referred to the Prudential Committee. It is quite likely that the contract will be awarded to the North Adams Gas Company.

WRITING of North Adams puts us in mind of the fact that we are indebted to Frank Richardson—whose connection with the North Adams Gas Company does not prevent him from ably filling the position of Treasurer to the United Zylonite Company, of Zylonite, Mass.—for a very handsome calendar, in a beautiful specimen of dead white zylonite ware. The supporting sheet carries white and gold panels, showing the

zylonite company's works, which are illustrated on a back sheet in the finest style of the celebrated art house of Jno. A. Lowell & Co., of Boston. The supporting and back sheets are held together by means of gilt rivets, the calendar cards are at the base of the second panel, and the means for suspension is found in a tastefully knotted loop of pink-scarlet ribbon. Take it all in all, it is about as handsome a calendar as ever graced the walls of the JOURNAL office, and we are obliged to the zylonite man for his kindly remembrance.

FROM the report of the Paris (France) Gas Company, for the twelve-month's operations ended Dec. 31, 1888, it is seen that the gain in new consumers for the period under review was greater than that recorded in any other year in the history of the Company. The increase was 11,980; the total number on the rolls, Jan. 1, 1889, being 212,515. The nearest approach to this gain was in 1881, when 11,025 new customers were secured. The use of stoves and other appliances for consuming gas other than for illuminating purposes is becoming more notable every day—47,051 gas cookers and heaters have been placed. The day consumption—allotting this to the hours between the extinction and lighting of the public lamps—is returned at 25 per cent. of the entire output, which latter amounted in 1888 to 10,520 million cubic feet. The Company operates 1,346 miles of street mains.

MR. ROBT. A. STRANAHAN, of Buffalo, N. Y., who is largely interested in the fortunes of the Medina and Tonawanda (N. Y.) Gas Companies, is one of the quartette who, under leasehold, will hereafter operate the Tremont House, Boston. New York gas men visiting the Hub might do well to bear this in mind.

MR. EDMUND CATHELS, who for some time has been acting as gas engineer for the Calumet Iron and steel Company, South Chicago, has been appointed Superintendent of the Joliet (Ills.) Gas Light Company.

PROMPT action is all that prevented a costly conflagration, on the morning of the 10th inst., in the William street storage sheds of the Montreal Gas Company.

LATE news is to the effect that the plans and specifications submitted by Engineer Smedberg to the Hamilton (O.) Council for the "first station" of the proposed municipal gas works have been accepted.

THE Directors of the Hackensack (N. J.) Gas Light Company have decided to carry out a scheme of plant betterment. It is also probable that considerable additions will be made to the main system. This Company is rapidly augmenting its business.

THE electricians often refer to Newark, N. J., as a bright particular star in the firmament of electric lighting advance. We do not wish to be understood as saying that Newark does not figure as a place in which electrical illumination is largely availed of; but we unhesitatingly affirm that whatever advance has been made in the output of electric lighting has not been made at the expense of the two local gas companies. This we know from the returns as to income made to the State Board of Assessors by the gas companies. Taking their gross receipts in 1885 and comparing these with those of 1888, we find the percentage of increase to have been slightly in excess of 22, net.

PINE BLUFF, Ark., may enjoy (?) a third company for the purpose of supplying gas, the rumor being that Messrs. N. M. Jones, John O'Connell, and H. P. Bradford have applied to Council for an ordinance permitting them to establish and operate a gas works. It is possible that the N. M. Jones in the above trio is the clever President of the Memphis (Tenn.) Gas Light Company, and an associate of the coal magnate of Pittsburgh, Mr. S. S. Brown—whose other claim to fame is that of having won a famous Eastern handicap with a racehorse named Troubadour. Admitting that it is easier to sell gas coal, or even to make gas, than it is to win handicaps, we would respectfully urge upon Messrs. Jones and Brown the great weight that they would have to take up in making the running for the gas supply of Pine Bluff. Better pay the forfeit, gentlemen, than to insist in this instance on going to the post.

AT the annual meeting of the Bangor (Me.) Gas Light Company the following result was reached: President, T. U. Coe; Treasurer, W. S. Dennett; Secretary, Henry Boardman; Superintendent, A. H. Parker; Directors, T. U. Coe, F. A. Wilson, A. C. Hamlin, J. F. Colley, and C. P. Stetson.

Acting under the suggestion of City Engineer Rice, the Cleveland (O.) Council named Messrs. Bayne, Rice, and Logue a committee to frame an ordinance under which the city shall have appropriate tests made of the candle power, etc., of the various lighting agents supplied under contract.

AT a meeting of the Allegheny (Pa.) Select Council, Mr. Snaman offered a resolution directing the Committee on Gas to advertise for proposals for an electric light plant, the successful bidder to operate the same for a term of six months prior to the purchase of the station by the city. Mr. Lare offered an amendment to the effect that the plant, when erected, be rented by the city for one year, the city to then have the privilege of buying outright. Mr. Hartman thought that it would be more business-like to call for bids, award the contract, and accept the results. The Lare amendment was rejected, whereupon the Snaman suggestion was adopted.

"SOME time ago I wrote you to the effect that a scheme, engineered by the proprietors of the Hartford Light and Power Company, for furnishing fuel gas in Hartford, was being considered by the joint Incorporations Committee of the reigning Connecticut Legislature. Presuming that what I then wrote you about the status of the case need not be here repeated, I will pass on to its standing now, only claiming the right to remark, as the result of some study of the affair, that this attempt is simply to put life or value in the worthless stock of the old Hartford Steam Company, and that this life or value is to be obtained at the expense of the Hartford Gas Light Company; for no one in this neighborhood that is at all capable of reflection thinks for a moment that the backers of the fuel project really mean to stop at the distribution of fuel gas. No; it is an open secret that what they wish is to war on the Hartford Gas Light Company, indifferent as to whether the outcome will be suicide or surrender. Much to the surprise of many a bare majority of the Committee (composed of 9 members) reported in favor of the grant asked for. Those agreeing (Messrs. Fuller, Adams, Carpenter, Chester and Baxter) did not seem to have very weighty arguments to present in support of their decision; for they merely said that the prayer of the petitioners ought to be favorably entertained. On the other hand the minority report (signed by Messrs. Mowry, Dewey, Palmer and Holden), a copy of which I inclose, gives good and cogent reasons why the State should not play into the hands of the holders of flotsam charters, and why the undoubted rights of the Hartford Gas Light Company should be protected. In the meantime one of the majority signers (Mr. Baxter) asserts—or his friends do for him—that he affixed his name to the report while under a misapprehension, and that he now wishes to go over to the minority. His "misapprehension" is said to be that he thought the Company merely wished to supply the gas only in the immediate vicinity of the works, and for experimental purposes solely. I admit that the member from Colebrook puts forward an interestingly diaphanous excuse; and it is agreed on all sides that 'he ought to have known better.' However, the schemers have very much further to go before the sum of their desires is reached; and although I confess that their having secured a favorable—may I term it misapprehensive—report is beyond the stage that I ever expected them to land, I belive that the road beyond is likely to be a rugged one.—HADDAM."

The minority report referred to by our correspondent is appended:

"The joint standing Committee on Incorporations, to whom was referred the Senate resolution No. 14, being the petition of the Harttord Light and Power Company for an amendment of its charter, granting it power to furnish gas for fuel purposes, make report as follows:

"The Hartford Light and Power Company was chartered by the legislature of 1887 to furnish electricity for any purpose, within the city of Hartford. Its capital stock is now $102,000. Its plant is located at the works of the Hartford Steam Company on Pearl street, and, as shown before the Committee, its business of furnishing electricity for light and power has always been, and still is, very profitable.

"Soon after its organization, it bought enough stock of the Hartford Steam Company to control it, having at this time over $60,000 of its stock, and $40,000 of its notes; thus controlling the management and direction of the Steam Company, conducting and carrying on its business in a limited way, but as best pleased them, and ignoring entirely the minority stockholders, and since conducting it, have done so at a loss. The charter of the Light and Power Company like all similar charters for corporations of a like nature, restricts its business to furnishing electricity; so that in buying and carrying on the steam-heating business, and investing its capital in it, it has been doing that which it has no authority to do, and which has been decided by the courts to be unlawful; and although this point was not fully brought out at the hearing, it is thought well to allude to it here, that the Light and Power Company in investing in and managing the Steam Company, are doing so in direct violation of their charter, and are carrying on a business

which they testified did not pay, and which was one, if not their principal reason for asking for this amendment.

"The original purpose of the amendment was to authorize the Light and Power Company to use the plant and pipes of the Steam Company for making and distributing gas for fuel purposes; but as some of the stockholders appeared before the Committee and protested against such use being made of their property, and their own witnesses testified that on account of the size of pipes it might not be altogether feasible, they admitted that they should undoubtedly lay down and use pipes of much larger size, similar to those used for ordinary gas. There did not appear before the Committee a single person not interested in the present Light and Power Company, other than the inventor of the process they would use and his expert, who said there was any demand for fuel gas other than that already supplied by the Hartford Gas Company, nor did they name any city where it was now in successful operation.

"The amendment was opposed before the Committee by the Hartford City Gas Company, who showed that they are now and have been for some time supplying their gas for fuel purposes, having at the present time about 1,500 gas stoves in use; and that 20 per cent. of their entire annual output of gas, at the present time, is used in domestic uses of heating and cooking; and in manufacturing places in this city for various purposes, as well as in running several gas engines, and at a price less than it could be furnished by the Steam Company, if their charter were amended.

"The plant, street mains, etc., of the Hartford City Gas Company have cost over $700,000, and are in the assessor's list at a value of $570,000.

"The Light and Power Company's capital stock is $102,000, assessed at $5,000; and the capital stock of the Steam Company is $112,000, assessed at $25,000.

"The Hartford Gas Company now furnish gas at $1.40 per thousand of good quality, and which is cheaper than any other city in the State, and, with but few exceptions, in the United States.

"Your committee, therefore, upon the full hearing, find that there is no demand for fuel gas; and there is no process of producing it yet known that is not dangerous and unsafe; that the location of the present steam plant being, as it is, in the center of the city, is not a suitable place for a gas plant; that the Hartford Gas Company are now supplying, and have facilites for supplying, any increase in the demand for gas for fuel purposes; that it would be against public policy to grant the amendment."

In order to complete this matter we herewith reproduce the majority report:

"*Section* 1. That the resolution 'incorporating the Hartford Light and Power Company,' passed at the January session, 1887, of the general assembly, and approved April 25, 1887, be and the same is hereby amended by adding after Section 13 of said resolution the following:

"*Sec.* 14. Said Company, in addition to the powers and privileges already conferred by said resolution, is hereby authorized and empowered to manufacture and distribute within the city of Hartford, gas for fuel purposes only, and to that end may lay down and use within the streets and public places of said city, hereinafter specified, all necessary pipes and conduits for the distribution of such gas, and may erect suitable and convenient buildings and works for the proper conduct of said business; provided, however, that in the erection and location of such buildings and works the approval of the Board of Health and of the Building Inspector of said city shall first be secured; and provided, further, that nothing herein shall be construed to authorize or empower said company to manufacture, sell, or distribute gas for illuminating purposes, for the manufacture, sale, or distribution of gas for such purposes is hereby expressly prohibited.

"*Sec.* 15. The provisions of this resolution apply only to the streets, territory, and public places lying within and including the following boundaries, viz.: beginning at the junction of Main street and Capitol avenue and running thence west through Capitol avenue to the railroad, thence along the railroad northerly to Albany avenue, thence easterly along Albany avenue and Main street to Talcott street, thence east through Talcott street to the Connecticut river, thence south along the Connecticut river to Grove street, thence westerly along Grove to Main street, thence south along Main street to Capitol avenue; provided, however, that if the works aforesaid shall be required to be located outside of the limits above prescribed, the Company shall have the right to lay its pipes to the most practicable point of connection with said territory, for the purpose only of making such connection; provided, further, that all work done under the authority of this act in laying pipes in the streets of said city shall be done to the satisfaction and approval of the Board of Street Commissioners, the consent of the Common Council thereto having first been obtained.

"*Sec.* 16. This amendment shall not be operative until accepted by the company at a meeting specially called for that purpose within six months after the approval of this act, nor until a certificate of such acceptance signed by the President and Secretary of the company shall have been lodged with the Secretary of State."

Elastic Foundations for Dynamos.

As dynamos and steam engines are being introduced more and more into private houses and in neighborhoods where the vibration occasionally accompanying their operation is objectionable, some means of preventing the trouble is of special interest. In a recent communication to the Societe des Ingenieurs Civils, M. G. Anthoni describes a method of overcoming the difficulties caused by vibration and noise from engines, and the point upon which he lays special stress is, in the case of machinery, the increase of the mass of the system to be isolated and its carriage by an elastic body, such as rubber. A large trench is dug out, at the bottom of which is placed planking surmounted by a covering of sheet iron, on which are distributed a number of rubber cylinders, constituting at the same time an elastic and electric insulation. On the top of the cylinders there is placed a second plate of sheet iron riveted to a framework so as to give stiffness to the whole. On this is built a foundation in the usual way, provision being made for the foundation bolts, and sufficient space being left to properly allow of periodically cleaning the trough of any extraneous matter without disturbing the elastic support. The foundation need not be of masonry, and in some cases it might be advantageous to replace it by a caisson filled with sand, which may be easily transported. The trench surrounding the foundation is covered at the top by a plank forming a border, but so as to allow of horizontal movement. The steam and exhaust pipes are given a spiral turn at their upper ends so as to permit of their being elastic under the movement which takes place, and so as to avoid the springing of joints.

Straightening Walls of Buildings.

D. Lardner explains that when the weight of the roof of the large gallery of the Conservatoire des Arts et Metiers pressed the sides outward so as to endanger the building, it was essential that means be adopted by which the wall should be propped so as to sustain the roof. M. Molard contrived the following ingenious plan for the purpose: A series of strong iron bars were carried across the building from wall to wall, passing through holes in the walls, and were secured by nuts on the outside. In this state they would have been sufficient to have prevented the further separation of the walls by the weight of the roof, but it was desirable to restore the walls to their original state by drawing them together. This was effected in the following manner: Alternate bars were heated by lamps fixed beneath them. They expanded; and consequently the nuts, which were previously in contact with the walls, were no longer so. These nuts were then screwed up so as to be again in close contact with the walls. The lamps were withdrawn, and the bars allowed to cool. In cooling they gradually contracted, and resumed their former dimensions; consequently the nuts, pressing against the walls, drew them together through a space equal to that through which they had been screwed up. Meanwhile the intermediate bars were heated and expanded, and the nuts screwed up as before. The lamps being again withdrawn, they contracted in cooling, and the walls were further drawn together. This process was continually repeated, until at length the walls were restored to their perpendicular position. The gallery may still be seen with the bars extending across it, and binding together its walls.

Recent Patent Issues.

The following list of recent patents relating to the gas interests is specially reported by Franklin H. Hough, solicitor of American and foreign patents, 925 F street, N. W., Washington, D. C.

ISSUE OF MAY 7, 1889.

402,655. Gas Burners for Grates and Stoves. I. A. Dailey, Toledo, Ohio.
402,749. Gas Engine. S. Lawson, N. Y.
402,750. " " "
402,751. " " "
402,787. Purifying Gas. Wm. Valon, Ramsgate, Westminster, England.
402,995. Water Gas Burner, W. F. Steele, Steele, Dak.

ISSUE OF MAY 14, 1889.

403,283. Gas, Apparatus for Production of. W. Naysmyth, Pittsburg, Pa.
403,297. Gas Meter. W. Y. Stansbourgh, Brooklyn, N. Y.
403,367. Gas or Gasoline Engine. L. C. and B. Parker, Kansas City, Mo.
403,370. Gas Engines, Dynamo Speeder for. N. Rogers and J. A. Wharry, Terre Haute, Ind.
403,377. Gas Engines, Carburetor. N. Rogers and J. A. Wharry, Terre Haute, Ind.
403,378. Gas Engine Governor. N. Rogers and J. A. Wharry, Terre Haute, Ind.
403,381. Gas Manufacturing. J. M. Rose, Allegheny, Pa.
403,382. " " " "
403,383. " " " "
403,384. " " " "

THE AMERICAN GAS LIGHT JOURNAL

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PROPRIETORS.

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MONDAY, MAY 20, 1889.

The Market for Gas Securities.

This week the management of the Consolidated Gas Company will pass on the dividend question, and there is more reason now than ever for presuming that the rate will be advanced to 2½ per cent. To-day (May 17) the stock sold up to 91¾, and we think that it is a bargain up to 98, or even to par. One notable thing in connection with the Company's business, as is the case with all the other city companies, is the great increase in day sendout.

The retail dealers in cooking stoves, etc., report unusual activity in business, and as almost every sale made will represent at least a monthly consumption of 1,500 cubic feet of gas, it is easy to comprehend the ultimate result to the gas companies. We look confidently forward, and do not think we shall have to wait very long either, to the time when 33 per cent. of the Consolidated Company's output will be used in the hours of daylight. It is true that this demand and supply will call for manufacturing plant extensions; but in what direction could money be more safely invested? Within another twelvemonth the Company's main system will be ample for all purposes—save with the possible exception of the district towards the Hudson river shore, north; but that defect can be easily remedied. Other city shares are strong. Mutual (16 shares) gas sold at auction this week for 102½. The Standard Company managers have squeezed out a one per cent. dividend on the preferred shares, and we congratulate them. It must have been hard work.

Over in Brooklyn the situation remains unchanged. New York capitalists, however, are said to have an eye on the Union Gas Light Company, of the 26th ward, with a view to acquiring control in same for the purpose of introducing fuel gas. We are extremely sorry to have to say that no improvement takes place in Col. Armington's condition, his southern trip not having been productive of much relief. Brooklyn gas, at auction this week (400 shares), brought 104½. The long-expected scrip issue by the Newark (N. J.) Company has been made. It amounts to 50 per cent. of the capital stock. The St. Louis merger is a fixed fact, and the Laclede interest will undoubtedly rule. The deciding meeting will be held on July 10, at the Laclede office. Cincinnati gas is up to 215. Stockholders of record, May 5, 1888, in the Consolidated Company of Baltimore, are entitled to a dividend of $1.275 per share—representing the divisible balance of the trust estate.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks,

16 WALL ST., NEW YORK CITY.

MAY 20.

☞ All communications will receive particular attention. The following quotations are based on the par value of $100 per share. ☜

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	91¾	—
Central	500,000	50	—	—
" Scrip	220,000	—	47	57
Equitable	4,000,000	100	113	122
" Bonds	1,000,000	—	113	115
Harlem, Bonds	170,000	—	—	—
Metropolitan, Bonds	658,000	—	116	118
Mutual	3,500,000	100	103	105
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern	125,000	50	30	—
" Scrip	108,000			
Yonkers		50	90	100
Richmond Co., S. I.	346,000	50	—	—
" Bonds	20,000	—	—	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	104	106
Citizens	1,200,000	20	72	75
" S. F. Bonds	320,000	1000	—	103
Fulton Municipal	3,000,000	100	120	123
" Bonds	300,000		—	106
Peoples	1,000,000	10	71	73
" Bonds (5's)	368,000	—	97	—
" " (6's)	94,000	—	100	—
Metropolitan	1,000,000	100	88	90
Nassau	1,000,000	25	111	113
" Ctfs	700,000	1000	100	103
Williamsburgh	1,000,000	50	119	122
" Bonds	1,000,000	—	109	112
Out of Town Gas Companies.				
Boston (Mass.) Gas Co	2,500,000	500	240	—
Buffalo Mutual, N. Y.	750,000	100	90	95
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	150	—
" " Bonds	45,000	—	—	—
Chicago Gas Trust	25,000,000	100	53⅝	—
Cincinnati G. & C. Co.	6,000,000	100	214	218
Consumers Toronto	1,000,000	50	192	—
Central, S. F., Cal.			75	90
Capital, Sacramento, Cal.			58	—
Consolidated, Balt.	11,000,000	100	43½	—
" Bonds	6,400,000		107	107½
Hartford, Conn	750,000	25	120	130
Jersey City	750,000	20	165	170
Laclede, St. Louis, Mo.	2,000,000	100	140	—
Louisville, Ky.	2,570,000	50	125	130
Little Falls, N. Y.	50,000	100	—	100
" Bonds	25,000	—	100	103
Montreal, Canada	2,000,000	100	204	210
Memphis (Tenn.) Gas	750,000	100	48	51
" Bonds	240,000	100	103	—
New Haven, Conn		25	193	197
Oakland, Cal.			34¾	35
Peoples, Jersey City		—	60	61
" " Bonds			—	—
Paterson, N. J.		25	99	102
Rochester, N. Y.		50	75	80
Syracuse, N. Y.	500,000	25	—	—
St. Louis, Missouri	600,000	50	—	—
San Francisco Gas Co.				
San Francisco, Cal.	10,000,000	100	59¾	60
Washington, D. C.	2,000,000	20	190	194
Wilmington, Del.		50	200	208

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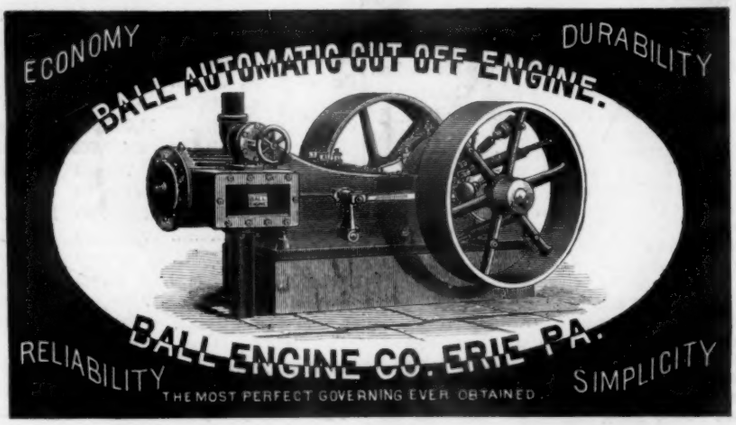

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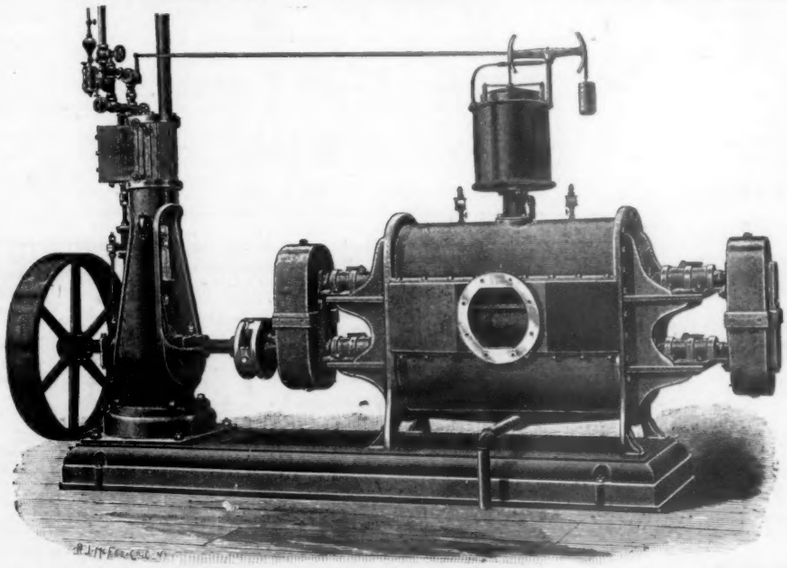

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Balmain, N.S.W	125,000
Bishops Stortford	150,000
Blackpool	400,000
Brussels	1,250,000
"	1,250,000
"	750,000
"	1,250,000
Banbury	250,000
Birmingham	5,000,000
Birkenhead	2,500,000
Blackburn	1,500,000
Bochum	600,000
Burntisland	250,000
Boston, U.S.A.	2,000,000
Brisbane	1,500,000
"	300,000
Burton-on-Trent	1,500,000
Barcelona	350,000
Barking	100,000
Baerlien & Co	20,000
"	20,000
Bombay	400,000
Buffalo, U.S.A., Mutual	750,000
" **Citizen**	500,000
Brookline, U.S.A.	500,000
Bergen	350,000
Berlin	1,250,000
Bournemouth	1,000,000
Bridgeport, U.S.A.	500,000
Brunswick	300,000
Beck & Co., St. Louis	100,000
Barmen Rittershausen	600,000
Bexhill	125,000
Brooklyn, U.S.A.	1,000,000
"	1,000,000
" **Nassau**	1,000,000
Brunner, Mond & Co.	400,000
Cheltenham	2,000,000
Cannes	200,000
Croydon	1,500,000
Copenhagen	200,000
Clevedon	200,000
Columbus, U.S.A.	500,000
Cincinnati, "	1,500,000
" "	1,500,000
Chicago "	3,000,000
" "	1,000,000
" "	1,000,000
Chemnitz	1,000,000
Crewe	1,250,000
Colonial Gas Works Co	100,000
Cadiz	300,000
Charlottenburg	600,000
Dudley	750,000
Driffield	100,000
Dukenfield	500,000
Dover	750,000
"	1,000,000
Deal	200,000
Derby	1,500,000

	Capacity. Cubic feet per day.
Dublin	3,000,000
Dowlais	100,000
Douai	500,000
Denton	500,000
Derby, U.S.A.	350,000
Denver, "	500,000
" "	1,000,000
Dusseldorf	750,000
"	500,000
Dumfries	250,000
Dunedin, N.Z	400,000
Darlington	1,250,000
Detroit, U.S.A.	750,000
Edinburgh	1,500,000
"	2,000,000
Enfield	300,000
Essen	300,000
Elbing	150,000
Falmouth	150,000
Frankfort	300,000
Farnworth	400,000
Fenton	400,000
Friedenshutte	500,000
Furth	400,000
Freiburg	200,000
Goole	250,000
Glossop	300,000
Guildford	300,000
Gloucester	1,250,000
Gera	300,000
Grafton, N.S.W	100,000
Grieg	300,000
Georgetown, U.S.A.	250,000
Gluckauf	200,000
Heywood	600,000
Holywood	125,000
Huy	70,000
Harrow	250,000
Harrogate	250,000
Halstead	150,000
Heilbronn	200,000
Havana, Cuba	750,000
Hastings	1,500,000
Huddersfield	300,000
"	750,000
"	1,500,000
Hof	200,000
Hampton Wick	500,000
Heckmondwicke	500,000
Haverfordwest	100,000
Halifax, N.S.	350,000
Hamm	200,000
Halle	400,000
Heidelberg	300,000
Hartford, U.S.A.	1,000,000
Ilkeston	300,000
Inverness	250,000
Ilkley	200,000
Ilford	100,000
Kingston-on-Hull	400,000
Kidderminster	750,000
Kidsgrove	100,000
Konigberg	1,000,000
King's Lynn	300,000

LONDON:—

The Gaslight and Coke Co.:	
Beckton	1,250,000
"	1,250,000
"	1,250,000
"	1,250,000
"	1,250,000
"	1,250,000
"	2,500,000
"	2,500,000
Silvertown	1,000,000
Bromley	2,000,000
"	1,500,000
"	1,500,000
"	1,500,000
"	2,000,000
"	1,500,000

LONDON—*Continued.*	Capacity. Cubic feet per day.
Shoreditch	2,500,000
Pancras	1,500,000
"	1,500,000
Pimlico	2,000,000
Nine Elms	3,000,000
"	3,000,000
South Metropolitan Co:—	
Greenwich	3,000,000
Woolwich	400,000
Vauxhall	3,000,000
"	3,000,000
Lea Bridge	300,000
West Ham	1,500,000
Leeds	2,000,000
"	3,000,000
"	3,000,000
"	3,000,000
"	3,000,000
"	2,000,000
Leominster	150,000
Leiden	560,000
"	600,000
Liverpool	2,000,000
"	2,000,000
"	2,000,000
"	2,000,000
"	2,000,000
"	3,000,000
Lincoln	1,000,000
"	600,000
Lowell, U. S. A.	1,000,000
Louisville "	1,500,000
Long Eaton	500,000
Lilie	900,000
"	450,000
"	750,000
"	250,000
"	250,000
Luckenwalde	330,000
Liegwitz	300,000
Lincoln, U. S. A.	250,000
Lawrence "	500,000
Lynn "	300,000
Lyons	1,500,000
Maidstone	1,000,000
Marseilles	1,500,000
"	1,500,000
Mons	500,000
Malines	250,000
Melbourne	1,500,000
"	1,500,000
"	1,500,000
"	1,500,000
"	1,500,000
Manchester	2,500,000
Middleton	400,000
Manley, N. S. W.	100,000
Minneapolis, U. S. A.	750,000
Magdeburg	300,000
Memphis, U. S. A.	750,000
Nottingham	1,250,000
"	2,500,000
"	2,500,000
"	2,000,000
"	1,500,000
"	2,000,000
Newport, U.S.A.	430,000
Newmarket	150,000
Newark, U.S.A.	680,000
Northfleet	200,000
New York, U.S.A.	2,000,000
Nice	600,000
Newcastle, N. S. W.	200,000
Numea, "	100,000
Namur	250,000
Newark	350,000
Oldbury	500,000
Otley	200,000
Oswestry	250,000

	Capacity. Cubic feet per day.
Ober Schlesian	1,500,000
Otto & Co.'s Coke Works	1,500,000
Plymouth	2,000,000
Parramatta, N. S. W.	100,000
Prescott	150,000
Providence, U.S.A.	750,000
"	750,000
Plauen	300,000
"	300,000
Portsmouth	2,500,000
"	2,500,000
Pittsburgh, U.S.A.	1,500,000
Portland, "	560,000
Pawtucket, "	500,000
Quebec	250,000
Radcliffe	750,000
Rouen	250,000
Ramsgate	1,000,000
Reigate	200,000
Richmond, U.S.A.	250,000
Roxbury, "	500,000
Runcorn Soap Co.	20,000
Rockhampton, N. S. W.	125,000
Richmond	1,500,000
Reading	2,000,000
Reichenbach	200,000
Salford	1,750,000
"	1,750,000
"	1,750,000
Smethwick	750,000
Sydney, N. S. W.	1,000,000
"	1,000,000
"	2,500,000
"	50,000
"	50,000
Sunderland	1,500,000
St. Josephs, U.S.A.	250,000
Spa	100,000
Sevenoaks	300,000
St. Petersburg	2,000,000
"	1,500,000
St. Louis, U.S.A.	2,000,000
"	2,000,000
"	1,000,000
Laclede	1,000,000
Silesian Coal Co.	600,000
San Francisco, U.S.A.	2,000,000
"	2,000,000
Sheepbridge Coal Co.	40,000
Stettin	200,000
Singapore	300,000
Sutton	500,000
Tonbridge	150,000
Tipton	400,000
Tottenham	1,000,000
Toledo, U.S.A.	750,000
Toronto	1,000,000
Uxbridge	300,000
Valparaiso	500,000
West Bromwich	1,000,000
Willenhall	250,000
Weston-super-Mare	500,000
Waltham	150,000
Wormwood Scrubs	300,000
Williamsburg, U.S.A.	600,000
"	600,000
Wellington	150,000
Warwick	300,000
Wheeling, U.S.A.	500,000
Walker	300,000
Westgate	100,000
Wilmington, U.S.A.	500,000
Windsor, N. S. W.	100,000
Wolverton	100,000
Wellington, N. Z.	250,000
Whitchurch	175,000
Washington, U.S.A.	2,000,000
Wallasey	750,000
Weimar	150,000
Wurzen	200,000
Worcester, U.S.A.	750,000
Yeadon	500,000
Yeovil	250,000

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Salina Gas Light Co.	Salina, Kansas.
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Morris Gas Co.	Morris, Ill.
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Sioux Falls Gas Co.	Sioux Falls, Dak.
Dakota Gas and Fuel Co.	Grand Forks, Dak.
St. Johns Mutual Gas Co.	St. Johns, Mich.
Stillwater Gas Light Co.	Stillwater, Minn.
St. Paul Gas Light Co.	St. Paul, Minn.
Emporia Electric and Gas Light Co.	Emporia, Kas.
Van Wert Gas Light Co.	Van Wert, Ohio.
Lansing Gas Light Co.	Lansing, Mich.
San Francisco Gas Light Co.	San Francisco, Cal.
Shelbyville Gas Light Co.	Shelbyville, Ind.
Great Falls Gas Light Co.	Great Falls, N. H.
Belleville Gas Co.	Belleville, Ontario.
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Northwestern Gas Light and Coke Co.	Evanston, Ill.
Lincoln Gas Light Co.	Lincoln, Neb.
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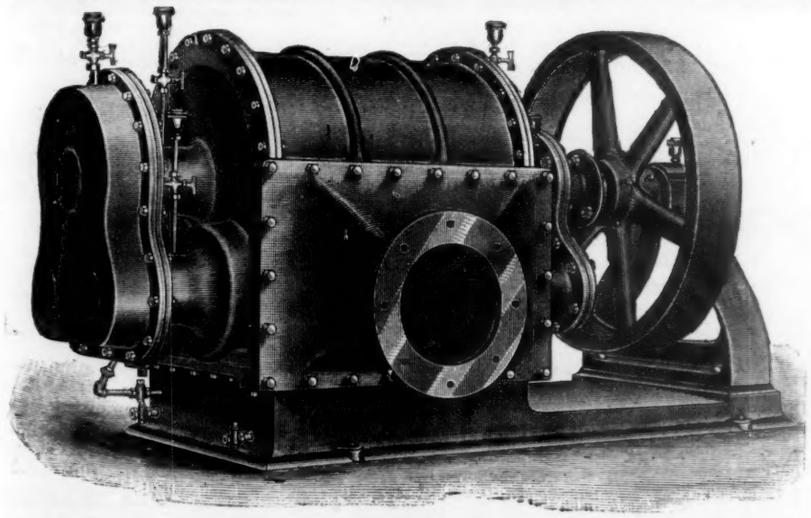

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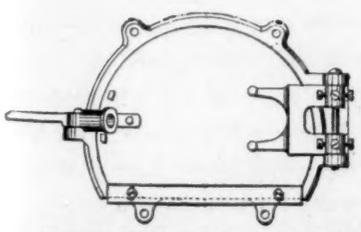

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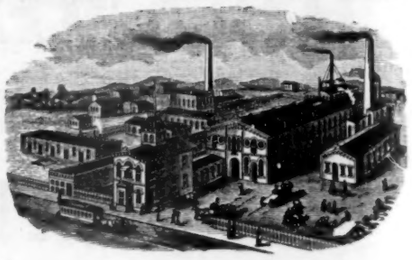

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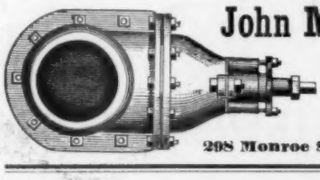

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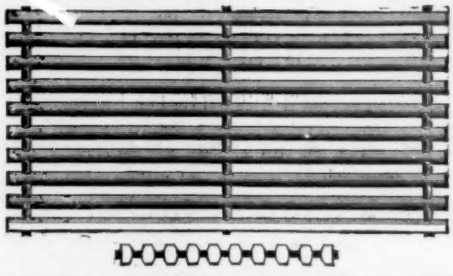

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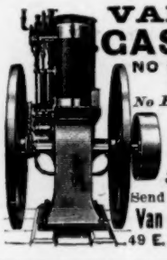

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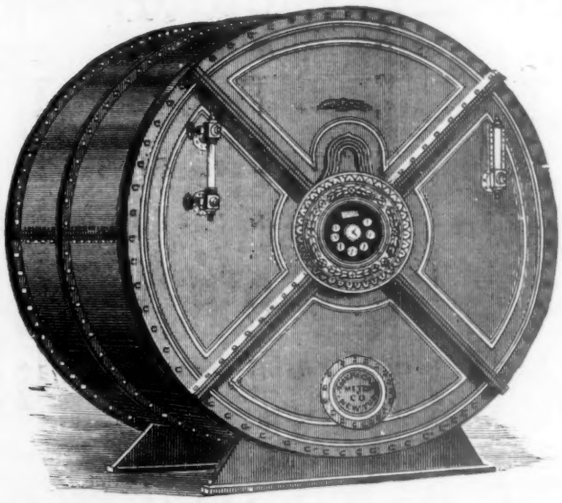

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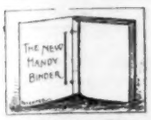

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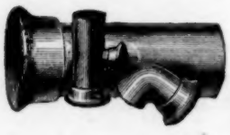

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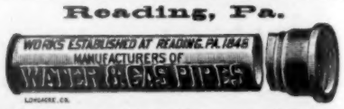

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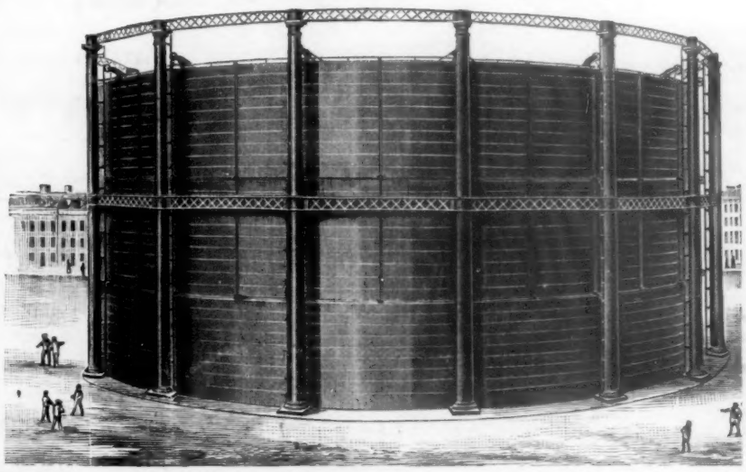

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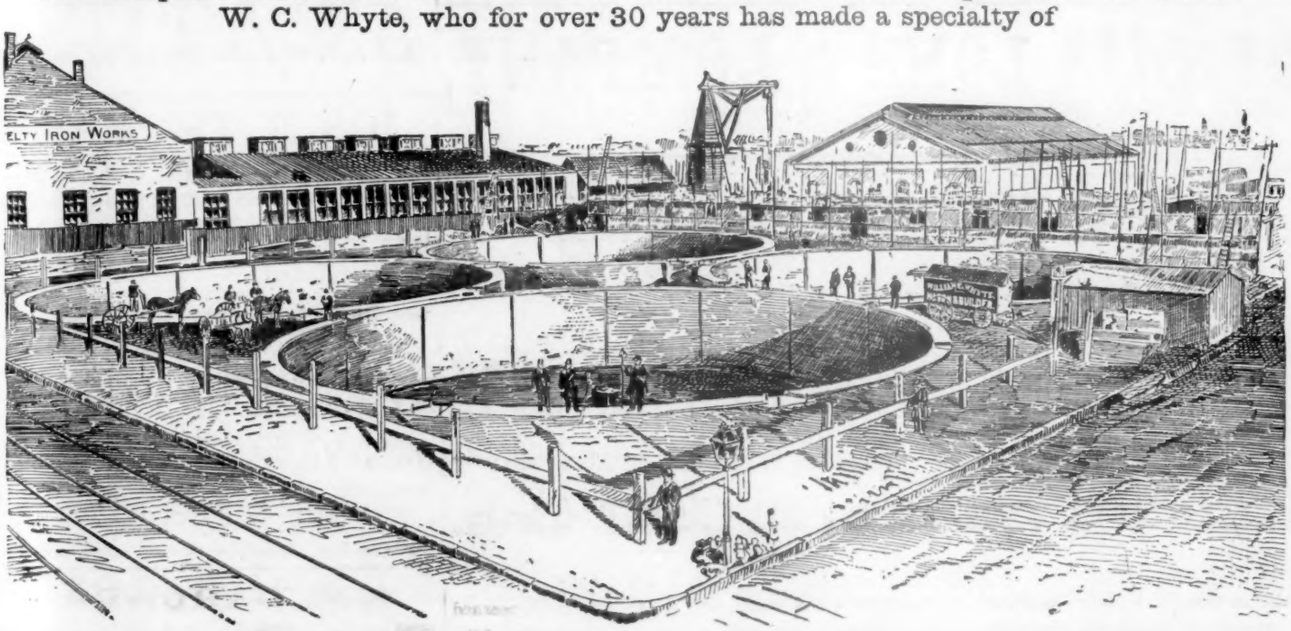

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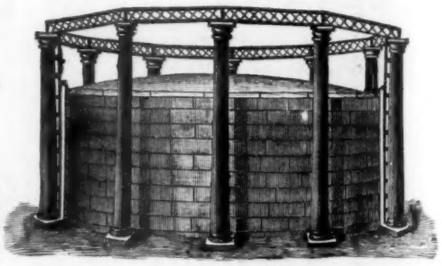

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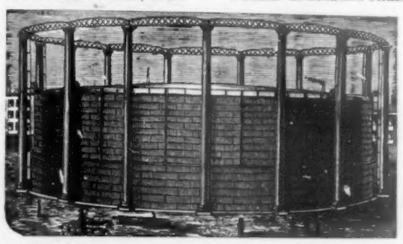

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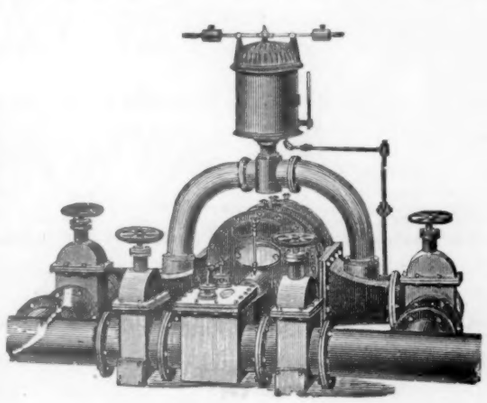

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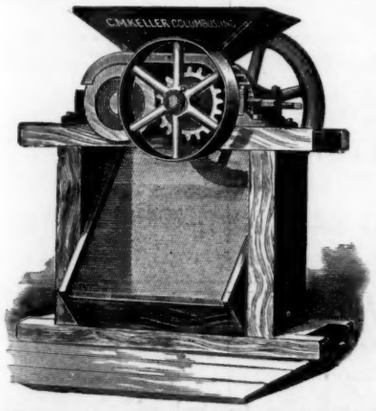

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50-H.P. STEAM ENGINE AND BOILER, Running a Plant of Fifty 2000-C.P. Arc Lamps 12 Hours.	
4,500 lbs. Indiana nut and slack, at $1.30 per ton	$2 93
Engineer, one night, at $50 per month	1 67
Trimmer, one day, at $40 per month	1 33
Superintendent or Electrician, one day, at $50 per month	1 66
Waste, etc., one day, at $20 per year	05
Water rent, one day, at $40 per year	11
Wheeling coal and removing ashes, at $4 per week	58
100 pairs carbons, at $18.50 per 1000	1 85
One pint cylinder oil, at 60 cents per gallon	07
One quart engine and dynamo oil, at 50 cents per gallon	13
Total	$10 38

50-H.P. OTTO GAS ENGINE, Running a Plant of Fifty 2000 C.P. Arc Lamps 12 Hours.	
9,200 cu. ft. gas, at 42 cts. per M. (for cost of gas see items below)	$3 86
Engineer not needed; engine is in care of Electrician or Supt.	....
Trimmer, one day, at $40 per month	1 33
Superintendent or electrician, one day, at $50 per month	1 66
Waste, etc., one day, at $20 per year	05
Water rent dispensed with (cooling water used over and over)	....
Handling of coal included in cost of gas	....
100 pairs carbons, at $18.50 per 1,000	1 85
One pint cylinder oil, at 60 cents per gallon	07
One quart engine and dynamo oil, at 50 cents per gallon	13
Total	$8 95

Expenses of depreciation, repairs, and interest omitted, being considered the same in both cases—though depreciation and repairs are much higher with steam on account of boiler and its appurtenances. Cost of gas in the holder we estimate for most of the Middle and Western States as follows: Coal, 30 cts.; labor, 20 cts.; purification, 2 cts.; total, 52 cts. Less coke, 7 cts., and tar, 3 cts.; leaving net cost of gas 42 cts. The items of Superintendence and repairs, being paid for by the gas sold to consumers, need not be charged on extra output for gas engine consumption. Where the cost of gas is higher than here figured, coal for steam use will be found proportionally higher, and final figures of comparison show same amount of saving.

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Coal for getting up steam and banking fires is not included in above figures, and should be added, thus increasing rate of economy of gas power beyond that shown by our figures.

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